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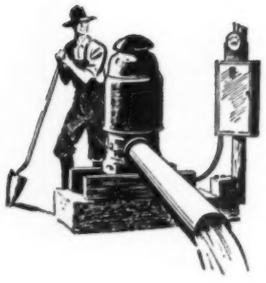

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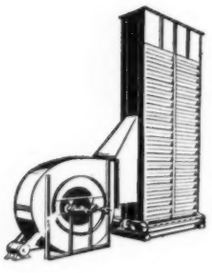

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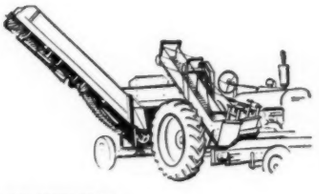

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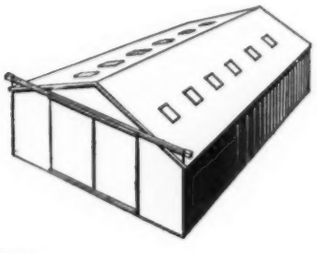

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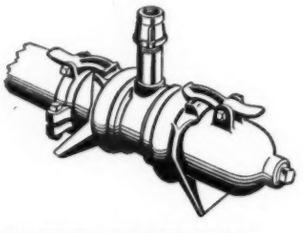

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WORLD CROPS

Editor: Sir Harold A. Tempany, C.M.G., C.B.E., D.SC., F.R.I.C.

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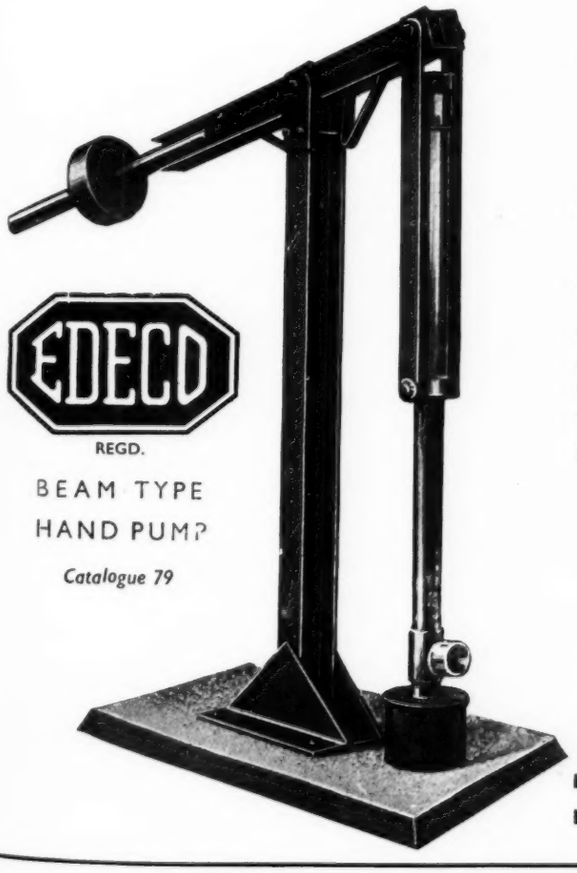

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Editorial Comment

Tea prices

THE recent rises in the price of tea on the world's wholesale and retail markets has caused general alarm and uneasiness especially in the United Kingdom where tea is par excellence the favourite domestic beverage. As is usual in such conditions, it has aroused speculation as to whether the wave of high prices may not be due to restrictive manipulation of the sources of production in producing centres by the producers for their own ultimate benefit. It has also given rise to a crop of statements to the effect that the Chinese Government is contemplating in the near future releases of large quantities of china tea for export to European markets, of the qualities and kinds which were well known in England before the last war, to help to fill the increased demand and to take advantage of the prevailing high prices.

In the circumstances, a recent speech by Sir Eric Miller, the Chairman of Harrisons and Crosfields Ltd., to the shareholders of that company in which he reviewed the international situation in relation to the present production and consumption of tea, was timely and of considerable interest and importance.

In his appraisal of the position, Sir Eric was at pains to point out that the present peak prices for tea followed a period of slump when tea prices fell to so low a level as to cause a number of estates in India to close down and threatened others with ruin. It is essential for the public to understand that the price at which tea is sold is not made by the producers, but is determined by those at which consignments are sold at the public auctions which are the standard method by which most of the world's tea is disposed of and which reflect public demand.

It is also to be noted that the figures for Indian production clearly show that there has been no restriction of output on the part of the producers last year inasmuch as Indian production in 1954 rose to approximately 630 million lb. as compared with 608 million lb. in 1953, while production in Ceylon rose by about 19 million lb. as compared with total output of 353 million lb. in 1953.

Actually, there has been a sharp increase in world demand for tea during the past year or so. Part of this has been stimulated by publicity and advertisement in, for example the United States of America, where the people are not normally tea drinkers, coffee being the preferred drink. Incidentally, it appears that the high prices current for coffee may not have been without effect in stimulating the growth of popularity of tea as an alternative. Another factor which is operative is the rapid growth in the demand for tea in the producing countries themselves, a demand which has been stimulated by the imposition of export quotas and export duties, the latter having been increased by the Indian Government partly by reason of the need for additional revenue to finance improved social services.

Looking to the future those who are well placed to judge seem to think that it is unlikely that there will be any real easing of the level of tea prices until after the middle of the current year when the prospects for the North Indian tea crop will become somewhat clearer. It is as well to realise that the crop in this region is in reality the dominant factor in the situation, rather than any additional marginal supply that may come out of China or any other alternative source.

In the meantime, there is no reason to imagine that the situation calls for action against the producers. It must be borne in mind that they have in the past been called on to face low prices and hard conditions for long periods and that the present high prices may not unfairly be regarded as some slight compensation for this. Moreover, even at present prices there is no sign of flagging in the demand, and in any case tea is still a cheaper drink than any of the alternative beverages.

In any case, it is only if producers continue to receive adequate revenues that they can be expected fully to modernise their fields and factories and so to enhance their productive capacity. Certainly, there is every reason to hope that in due time the statistical balance will be restored, but this can only happen when the law of demand and supply is able to operate freely.

Agricultural science in the U.S.S.R.

EVENTS and developments behind the iron curtain are always a subject which excites the keenest interest in Western countries and current developments in the science and practice of agriculture are no exception.

For long, Russian agricultural science has shown a marked tendency to be dominated by the pronouncements of a few highly regarded authorities, whose oft reiterated statements of principle were permitted to acquire a sort of sacrosanct character the verity of which the ordinary practitioner questioned at his peril. Of such were the teachings of the late V. R. Williams, that eminent Russian agriculturist with a Welsh name, whose work has been introduced to English readers by G. V. Jacks' translation of his book, reviewed in WORLD CROPS some time ago, or the remarkable findings of Lysenko or Mitschurin in the field of plant breeding and genetics.

Since the death of Stalin, however, a change seems to have come over Russian ideas in this connection, and the notion seems to be gaining ground that so far from it being desirable that the teachings of particular authorities should be endowed with the prestige which in other countries attaches to Holy Writ, a certain measure of informed criticism of the work of these scientists may be indeed desirable and necessary.

The following quotation from a recent article in *Pravda* seems to bear witness to this remarkable change of heart.

'The party calls for a struggle against dogmatism and scholasticism in agricultural science, against the monopoly of individual groups of scientists who push away rising young men and seek to resolve scientific questions by administrative means.

'Agricultural Science must develop on the basis of collective work by scientists; and by the broad popularisation of the advanced experience of Collective and State Farms, and by the close creative collaboration between workers in theory and practice.'

This indeed appears to betoken a remarkable change of outlook and indeed to the uninitiated, to strike at what seem to be the very roots of dialectical materialism. To western eyes and ears this apparent conversion to open mindedness on scientific questions is as welcome as it is astonishing.

Iron chlorosis

IRON deficiency or iron chlorosis as it is more commonly termed has been for many years a common occurrence in many countries, and until recently has been a difficult deficiency to correct. It may be caused by either actual deficiency of iron in the soil or by lack of available iron due to either excess of copper or manganese in the soil or a high soil content of calcium carbonate or a high pH value. The normal symptoms are a lightening of the colour of the areas between the veins on leaves coupled with a darkening of the veins themselves. In severe cases, the leaves fade to an ivory colour, the plants become defoliated and dieback ensues.

The remedy for these conditions is obviously to supply iron in a form which the plant can absorb, but application of the usual iron compounds is often ineffective because iron compounds become converted to insoluble compounds like iron phosphates or iron hydroxide which the plant cannot use.

From a recent article in *Agricultural Chemicals* it appears that work in America has directed attention to chelated compounds of iron as a possible means of surmounting the difficulty. It should be explained that certain organic compounds unite with metals to form 'chelates' in which the metal is held as a member of a ring structure (the name is derived from the Greek word meaning a claw). In chelates the properties of the metallic constituent become modified, for example in iron chelates the iron no longer possesses its characteristic iron properties, and can not form compounds like the phosphates and hydroxides, although it may remain readily available to plants when applied to the soil or the plant foliage.

In the U.S.A., at present, the iron chelate which is most widely used is the iron salt of ethylene diamine tetra acetic acid which has been given the name of FeEdta. A number of products containing this compound are now it appears on the market and are being used on a wide variety of crops and plants, notably on iron chlorotic citrus trees in Florida as well as on deciduous fruit in California and on vegetables and ornamental plants in both regions.

Among the firms marketing chelated compounds is the Geigy Chemical Corp. through its division the Alrose Chemical Co. which produces a brand of chelated iron compound under the trade name of Sequestrene R.

Phytosanitary certificates

THE December 1954 issue of the FAO Plant Protection Bulletin contains an article by Mr. C. J. Briejer of the Netherlands Plant Protection Service, who raises the question of the value of the certificates issued by exporting countries to accompany shipments of plants or plant products, which guarantee that such consignments are not likely to act as the means of transferring plant pests or diseases.

The author points out that there are at present some authorities on plant quarantine questions who assert that such certificates are in themselves worthless, and while not agreeing in toto with this dictum he points out that the value of such certificates must necessarily depend on the efficiency with which the Government of the exporting country performs the services in question.

In this connection, it is essential that the Government of the exporting country should maintain an effective plant protection service and should provide adequate and sufficient funds for its operation. In addition, the direction of the plant protection service should be fully aware of its responsibilities to have its inspections and other duties properly performed while all inspecting officers should be adequately technically trained and qualified and should be provided with all the equipment required for the performance of their duties.

Mr. Briejer insists that being given these requirements little importance can in reality attach to the wording of the phytosanitary certificates; usually such certificates bear evidence that the plant protection service of the country of origin has inspected a

consignment in the manner required by the regulations of the importing country.

In some quarters great importance has apparently become attached to the wording of these certificates but as Mr. Briejer quite correctly points out the efficient organisation of a plant protection service necessitates money, a sense of responsibility, technical knowledge and adequate equipment, and none of these factors can be affected by the wording of the certificates, neither can it affect in any way the manner in which inspections are carried out which is really the thing which matters. A certificate merely certifies that an inspection has been carried out, but gives no information as to how it was done. It is even possible for irresponsible officials to sign certificates without having seen the consignment to which it relates.

In the circumstances, it seems desirable that one simple standard form of certificate should if possible be agreed upon for all countries, and that in addition information should be collected concerning the composition of the phytosanitary services in all countries adhering to phytopathological conventions and also concerning the manner in which the inspection activities are carried out. Working in this way it might become possible for importing countries to assess for themselves the reliability of certificates in supplying a measure of protection against the introduction of plant disease.

Paper pulp v. weeds?

A NEW method of weed control is being investigated at Michigan State College. It is a mulch method that uses wet pulp made from waste paper for the mulch material; this is set round growing plants, and when the pulp dries to the hardness of cardboard it acts as a shield, preventing the growth of weeds around the plant throughout its growing life. The idea of weed control by mulching is not, of course, new; exclusion of light is the *modus operandi* of the method. But most mulch materials used have been too loose in nature to give a complete control and if weed plants actually penetrate the mulch layer they thrive vigorously by drawing nutrition and moisture from it. The idea of using paper pulp instead of such materials as straw, sawdust, hay, etc., seems to have originated in Hawaiian sugar-cane plantations. It was subsequently tried with even more impressive success by pineapple growers.

The pulp can be made with quite simple equipment from waste paper; old newspapers are said to be quite suitable. A long soaking is necessary, followed by mechanical agitation that ensures the shredding of the paper. Time and labour are the principal items of cost, not only in making the pulp, but also in placing it round seedling plants. Unfortunately, it is time and labour that are the most expensive costs in most modern countries today, and it seems likely from the start that this new method of weed control can be applied only to crop plants whose produce has a very high cash value. Its economic applicability might be much wider in less developed countries where labour for simple tasks is still relatively plentiful and cheap; there, however, the supply of waste paper may be much less abundant.

When we reflect upon the rate at which forests are denuded to provide civilisation with its daily flow of newspapers, the idea of re-using a small part of this soil-derived cellulose to increase crop yields is certainly attractive. Even if the prospects of economic utilisation seem to be narrowly limited at present, a thorough examination of possible uses is certainly worth while.

Foliar plant feeding

THE correction of trace element deficiencies by spraying crops with appropriate solutions is an accepted practice today, and one of much value when the deficiency is caused by soil conditions that 'lock up' the particular trace element. However, there has been some effort in recent years to extend this idea to the major nutrients, especially to nitrogen. Nitrogen does not suffer from soil fixation troubles, but there are practical obstacles to top-dressing some crops with solid nitrogenous fertilisers, *e.g.*, in very dry weather the response of grassland will be slow, or at a late stage in root crop development it may not be possible to draw the drill over the field without damage. Can sprayed solutions of, say, urea take the place of solid fertiliser top-dressings? Recent optimism in this direction has received a cold douche from research work at Jealott's Hill (*Agriculture*, **61**, 368, 1954). Tests with leys comparing the effects of urea solution sprays and solid dressings of 'Nitro-Chalk' failed to demonstrate any advantages for the spray method of application. At the same rates of nitrogen supply, yields of grass and of its protein content were inappreciably different. The figures were obtained over two seasons and in one of them conditions were very dry, which should have favoured the foliar spraying method. If advantages could not be measured, one serious disadvantage was certainly observed. Considerable damage to clover plants in mixed leys was caused by the spray treatment, though none appeared to be suffered by grass plants. Similar rates of application of urea in solid form did not result in damage to clover plants. In view of the fact that urea spraying is, in any case, a more expensive method of supplying nitrogen than giving the usual solid dressings, the case for this new development in crop-feeding seems to have been severely weakened by this British investigation.

There has been some tendency to combine nutrient spraying with the use of aircraft. This might seem attractive where inaccessible land is involved or where marshland pastures give dubious ground support to tractors. However, solid fertilisers can equally well be applied from the air and using spray solutions means that the aircraft must carry large weights of water. Perhaps, after all, the spray application method is best confined to its original purpose—providing very small amounts of micro-nutrients. It is not as if the traditional method of solid application for providing major nutrients is either costly or handicapped by soil problems.

Selective expansion

THE twentieth session of the Council of FAO appears to have been much preoccupied with the present surpluses of farm products and the fall in farm prices all over the world. In the latter connection, Mr. Roger Savary, who is the observer at present representing the International Federation of Agricultural Producers, familiarly known as IFAP, on the Council, seems to have had some particularly apposite and trenchant remarks to make. He pointed out that while farmers all over the world had responded nobly to the exhortations of FAO and the various national governments to increase their production, the most striking result so far had been not only a decline in the prices which farmers received for their products, which incidentally are getting more and more out of line with the prices of the articles which farmers have to buy as part of their normal expenses of operation, but also a serious decline in their personal incomes.

It is clear from figures published by FAO that farmers' incomes are falling progressively below the incomes of other social groups and the question naturally poses itself whether it really is equitable in a world in which so much depends upon increased production of food, that farmers' conditions should be allowed to deteriorate simply because they produce more food more efficiently.

This aspect is, it appears, likely to figure prominently in discussions in subsequent years. Meantime, and quite possibly as a result of the direction which events are taking, a new phrase has made its appearance in the vocabulary of FAO discussions, *viz:* the doctrine of 'selective expansion.' This apparently betokens a new approach to the problem of increased productivity and implies that production should be well balanced and take full account of efficiency, nutritional needs and market requirements. All of which seems an obvious truism, notwithstanding that acceptance of the new doctrine may ultimately involve FAO and its member governments accepting a new approach to increased production.

Indeed, one is impelled to wonder whether the new phrase may not run some risk of being accepted as one of those happy inspirations which to the less actively and critically minded bring great comfort, in much the same fashion as the elderly and devout feminine member of a religious sect in days gone by is said to have confessed to deriving great spiritual solace from 'the blessed word Mesopotamia.'

More views on vanadium

NEARLY twelve months ago (see WORLD CROPS, 6, 81, 1954), we discussed new evidence for regarding vanadium as an essential trace element for plants. Now some suggestions from New Zealand are giving this element a somewhat different role in plant feeding, *viz.* that of a substitute for molybdenum in feeding pasture crops. The position of molybdenum is now well established; it is needed in only very slight amounts but its absence profoundly disturbs the nitrogen metabolism of plant-life, particularly with leguminous plants. On Australian and New Zealand soils, so often low in trace element supply or availability, applications of only 2 oz. of molybdenum compounds per acre have had similar effects upon production as dressings of 2 tons of lime. But this has apparently led to over-dosage with molybdenum. Many farmers have refused to believe that such small rates can be effective and have interpreted 'ounces' as an error for 'pounds.' Unfortunately, excesses of molybdenum are toxic to cattle. If forage contains too much molybdenum, the uptake of copper is reduced severely. In short, molybdenum and copper are antagonistic in animal nutrition.

On the other hand, there is evidence to support the view that vanadium is an essential animal nutrient; although high dosage would be toxic, the margin of safety seems a good deal wider than that for molybdenum. At the same time, vanadium seems able to perform the functions of molybdenum in plant nutrition, not quite as effectively as molybdenum itself, but without serious shortcomings. Some basic slags contain as much as 0.5% of vanadium and have been given to grassland at a rate of 2 cwt. per acre, *i.e.* giving more than 1 lb. of vanadium to the acre; no ill effects have been subsequently observed with cattle though a similar application rate for molybdenum would almost certainly have toxic consequences. A strong plea has been made in the *New Zealand Agriculturist* (reprinted in Britain in the *Fertiliser Journal*, 41, 44[1], 1954), for the substitution of vanadium for molybdenum in grassland management. The first large-scale and deliberate uses of vanadium for feeding crops are likely to be based upon a presumed capacity to understudy another element.

Tropical Forestry

Some Aspects of Forest Problems Peculiar to the Tropics

The influence in the tropics of forests on climatic conditions and hence on agriculture is receiving increasing recognition. At the recent World Forestry Congress in India, special attention was devoted to this subject. The following discussion of the basic considerations involved was contained in a paper presented to the Congress prepared by the experts in forestry of FAO, and is reproduced from the FAO journal 'Unasylva.'

WHY should tropical forestry be discussed as though it were a separate topic? Is it to be regarded as a separate science or merely as a special application to tropical conditions of the 'forestry' that has hitherto been most highly developed in the temperate parts of the world? There has been much talk on this point which still continues, but the issue is more academic than practical. The basic principles of 'forestry,' whether relating purely to silviculture, policy or economics, are valid in all latitudes and for all work throughout the world. But admittedly the conditions in the tropics —physical, biological, social, economic and even political—and the ways and means of translating principles into practice are very different from elsewhere. It may be conceded, therefore, that tropical forestry, in the main, presents a series of special cases in each of the broad fields which together constitute what we call 'forestry.'

The tropical forest in the local economy

Correct appraisal of the forest's role in the economy of individual countries or sections of a country is needed the world over. In the tropics, a proper assessment is of special importance because on it may hinge all efforts towards economic development.

To the north and south of the tropical zones lie countries where economic development is, to generalise very broadly, well advanced and perhaps has already taken its final shape. In some instances, the forest serves its proper place, even though elsewhere it has been too much encroached upon. On the whole, forestry is a matter of applying known practices and techniques to known conditions.

In the tropics, on the other hand, lie many countries which are only on the verge of economic development—new countries, in an economic sense, where everything can be schemed in perspective. For the most part, the climate, soil and vegetation are such that deliberate planning is necessary to assure the maintenance of a proper equilibrium between the natural conditions and steady economic growth. But the problems to be faced are novel and involved; particularly is the forester confronted by the difficulties arising from the mixed character of tropical forests and from the great lack of knowledge of the useful products that can be drawn from them.

In planning for economic development, agricultural and industrial activities must be balanced. What makes the role of the forest so important in the tropics is that here, more than elsewhere, the forest is basic both to agriculture and industry. Therefore, it is necessary to decide:

1. The relative emphasis to be given to agricultural and industrial developments.
2. The place of the forest (whether permanent or temporary) in relation to the picture of rural development and farming proper, keeping in mind not only soil conservation and land capability, but also particular practices, such as shifting cultivation.
3. The place of forest industries in the general industrial development. The forest, as a renewable natural resource, may on reflection prove of primary rather than secondary importance.

Felling teak in Thailand

Before decisions can be made on these matters as a preliminary to full-scale planning, detailed area studies must be undertaken. And here we come to a first principle that must guide the forester in the tropics: *forestry in tropical areas must not be regarded only in the absolute.* Save in certain rich and densely populated areas, the possibilities for forestry must always be appraised against the local characteristics of soil, climate and vegetation, and against local customs, practices and rights of usage that are not abruptly to be changed or abolished. They must, in fact, be reconciled with:

(*a*) The general agrarian structure, and a comprehensive programme of soil conservation and sound land use.

(*b*) The overall economic development possibilities of the area, and a programme of balanced agricultural and industrial expansion.

Forest inventories

In speaking of a 'programme' we postulate a thorough knowledge of all the local circumstances, which in turn means a prior resources survey; in the tropics, a forest inventory is the most important part of any such survey. From our first principle, therefore, we infer that the basis of all planning must be the forest inventory. It is not possible to go into the technical details of special difficulties of making an inventory of tropical forests. But we can say that such inventories are complicated matters which, whatever the degree of detail required, cannot be carried through without the active co-operation of foresters actually working in the forest.

Shifting cultivation

In a predominantly agricultural economy, the next step will be a land classification into three major types, whether or not any particular land was originally under forest. These are:

1. Lands to be permanently dedicated to forest.
2. Lands to be dedicated permanently to agriculture.
3. Intermediate lands, suited to multiple use, and whose precise functions would be settled on economic grounds.

Some people regard shifting cultivation merely as a traditional form of forest use by the autochthonous population and a problem that the forester can be expected to solve either by total prohibition of the practice or by restricting it to specified areas. Others, on the contrary, only concerned with the agricultural aspects, wish to see the native farmers weaned from shifting cultivation to permanent settlement. The matter is far less simple and must be looked at against the background of the entire agrarian structure in a given tropical area.

Shifting cultivation, as traditionally practised by native inhabitants before the arrival of settlers from other areas, is not particularly dangerous. In the wet tropics, a state of equilibrium is commonly reached, first, because tillage is restricted to soils of suitable structure and chemical composition which, however, contrary to general belief, are limited in extent in forest zones and, second, because the forest clearing is part of a true crop rotation system which includes a forest fallow of sufficient duration to permit restoration of the tree cover and the regaining of soil fertility. Primitive communities who practise shifting cultivation customarily set self-imposed rules by:

(*a*) The use of suitable soils which do not deteriorate too rapidly after having been cleared.

(*b*) Crop rotation, which does not leave the soil too long exposed and which includes a sufficiently long forest fallow to permit both the restoration of the tree cover and of the humus.

(*c*) The choice of an area where the climatic conditions make possible a rapid and dense regrowth of trees to form a stable forest canopy.

With the arrival of new settlers and increasing populations, this equilibrium is upset for various reasons—changes in the types of food crops grown, larger food requirements as living standards rise and the introduction of cash crops. It becomes necessary to produce more and, since the villager is not able to increase his yields, he has to enlarge the area that he cultivates.

First, he tries to use more fully such suitable soils as are still available for shifting cultivation. But generally there is not enough of such land which is not at the same time too far from the community centre. The alternative is to cultivate poorer soils or to return more frequently to the same areas and reduce the period of forest fallow. The outcome in either case is gradual soil degradation, with a decrease in crop productivity and with unfortunate effects on the forest.

Shifting cultivation may be said to become dangerous as soon as it loses its nomadic characteristics, when, in fact, it becomes nothing more than regular cultivation of forest soils.

To obviate the bad results of malpractices two courses are necessary:

1. Measures must be stipulated that will maintain or increase crop output without causing soil deterioration.
2. The reservation of minimum areas of high forest where shifting cultivation is totally prohibited so as:
   (*a*) to effect soil conservation and maintain streamflow;
   (*b*) to meet local needs for timber and fuel wood and in other ways to provide for a balanced economy.

This over-simplified sketch of the problem of shifting cultivation is sufficient to indicate the solution to be sought and the forester's responsibility. Improvement of shifting cultivation practices must be based on planned use of soils and forests. It is thus contingent on forest inventories, and depends on local circumstances, the possibilities of introducing various agricultural and silvicultural techniques, and present or prospective social and political conditions.

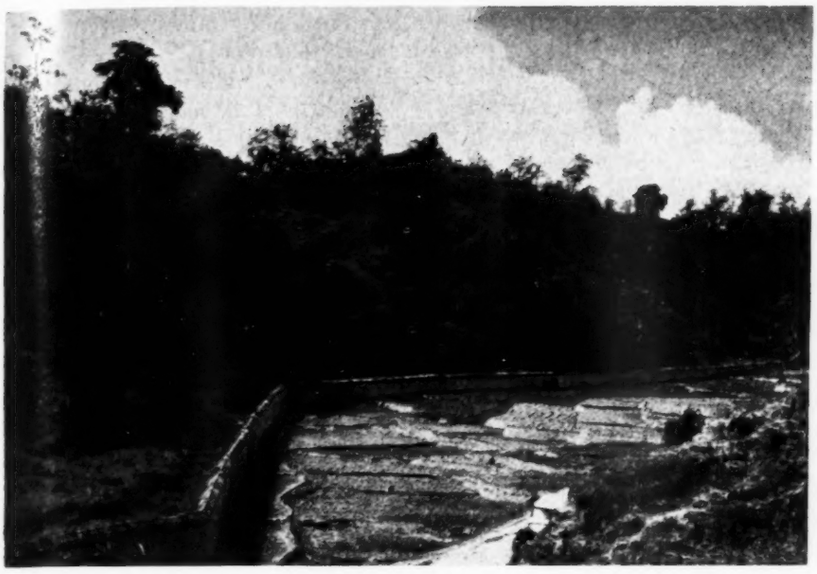
Wherever shifting cultivation is practised, forest policy cannot properly be formulated or implemented, either for protection or to promote development, without taking all the various factors involved into account.

Management and treatment of the forest

Planning is not possible without some understanding of the relative value of the elements involved. In the tropics, with few exceptions, the present and even more the future value of the forest capital is hard to assess. Any development scheme based on forestry must therefore be drawn up on the forester's appraisal of the forest.

We may be sure that, except in the case of purely protective forest, no forester wants to leave the heterogeneous growing stock of tropical forests to nature. The complex composition of the stands and the poor quality of most of the timber make extraction and utilisation difficult, both from the point of view of methods and economics. But the forester has to set the need to convert the forest against the danger that conversion may upset the particularly delicate ecological balance.

Commercial exploitation of tropical forests has in general been restricted to a small number of merchantable



A forest area in the Kathmandu valley, Nepal

species; foresters have tried to increase the proportion of these in the growing stock, either artificially or by improvement fellings, sometimes both together. To do so they devised and perfected a variety of methods.

Gradually, the number of merchantable species accepted on international markets grew, domestic demand rose appreciably and woodworking industries able to absorb many more species of mixed forest types became established in the zones of tropical forest. All this gave rise to the admirable concept of total utilisation of tropical forests.

Although this was theoretically the goal, in practice total utilisation remained impractical or prohibitively expensive, even with the help of certain chemical industries which could use wood of any kind. The aim was therefore modified to optimum use of the products of the tropical forest, and in some cases it became possible to set the number of economically usable species at a high figure. Silviculturists tried to devise methods permitting optimum use of the maximum number of species and economic conversion of the growing stock into less heterogeneous, and hence more fully utilisable, types.

The difficulties encountered in introducing the various techniques required to this end have led many experts to advocate the eradication of virgin tropical forest and its replacement by pure stands. This attitude seems today to be gaining ground, chiefly as a result of recent surveys made with a view to establishing new pulp mills in the tropics. Because of the rapidity of growth of certain species under tropical conditions and the technical advantages of working pure stands, many people recommend the creation of pure softwood or hardwood stands as the only solution to the problem of continous supply to proposed new pulp mills.

Broadly speaking, then, three schools of thought have emerged in tropical forestry:

1. Improvement of existing stands.
2. Gradual conversion of mixed forest into less heterogeneous types.
3. Transformation of mixed growing stock into pure stands.

It seems reasonable to infer that:

1. It is essential to alter the composition of heterogeneous virgin forest.
2. Conversion should render easier the economic extraction and utilisation of forest products.
3. Some methods of conversion may be dangerous both to the forest and the soil.

Therefore, we may say that tropical forestry must, wherever possible, seek to convert a heterogeneous growing stock into more readily and economically usable types, but conversion techniques must have due regard to climatic, soil and vegetation conditions so that the new stands to be formed shall be stable and without hazard.

In many cases, this principle will most properly lead to gradual conversion of stands through improvement by normal silvicultural methods. However, it does not preclude making radical changes under proper safeguards, such as artificially introducing native or exotic species, even in the case of protective forests, though here the concept of stability is of cardinal importance and must be the prime concern of the forester.

This principle also holds good for reforestation in arid regions, where the forests are ordinarily of no great economic value and serve principally a protective role. It is common experience that cash yields are the best argument for the protection of a forest. Even here, then, a cautious enhancement of the commercial value of the forest is advisable. In considering our second principle economic considerations are always to the fore. A third which we will try to formulate rests purely on economic factors.

All experience shows that large-scale forestry operations cannot be undertaken purely on technical grounds. To be practicable they must eventually be able to pay their way, preferably in hard cash.

It is always technically possible to reforest an arid area or convert a mixed tropical forest into a stand of more desirable composition. The crux of the matter is whether such an undertaking is financially sound. Tropical forestry needs in most cases to get beyond the purely silvicultural research stage, however desirable this may be in itself, and to have regard more to economic considerations. We would, in fact, suggest a third principle of tropical forestry to the effect that forestry must especially be orientated toward perfecting techniques and practices that are sound financial propositions, given the difficult local conditions, the forest types, the social structure of the country, and, above all, the uncertainty of future requirement trends, so much less easy to predict than in the temperate zones. Techniques and practices must be appraised not only on the basis of the cost of initial work required, but also on the probable cost of subsequent operations that will become necessary.

This principle seems particularly important because it lays stress on local circumstances. For instance, desirable silvicultural practices, such as improvement thinnings in heterogeneous forests, may be practicable in densely populated countries like Puerto Rico or Java, where the products have an appreciable market value and the proceeds can help defray the costs of the operations. In the Amazon or parts of Africa, on the contrary, the products are just so much waste. So are the intermediate yields from artificial plantations established either for protection or timber production when there are as yet no local markets. Such forestry undertakings are, therefore, risky and of value only over the long term.

Foresters must be sure what finally they want to achieve before choosing their silvicultural methods and assessing the probable results.

Industrial aspects of tropical forestry

At this stage, we may attempt to clarify the principles underlying industrial developments in tropical areas, though this lies somewhat apart from forestry proper. There are two principles which should govern how the forest shall be managed, the one a corollary of the other. First is the total utilisation of the tropical forest and secondly the integration of forest industries. Recent experience in under-developed countries has shown how difficult it is to put either fully into practice.

During the early development of a country it is not financially practicable to establish properly integrated forest industries or special industries that can utilise all available products. Planning must be on a practical business basis and the initial start must be made with industries that are both technically easy to establish and sufficiently profitable to amortise the capital investment. It is a question, above all, of markets, although even the initial industries should be designed with a view to their ultimately fitting into a pattern of fully integrated use of the forest as markets and finance permit. The principles remain valid, but they must be realised slowly.

Special protection problems in arid zones

So far our discussion on tropical forests has related primarily to the humid tropics. But the forester may also be confronted with dry, semi-arid and arid, and even desert, areas. Without wishing to raise arguments as to the origin and evolution of the special climatic conditions in such regions, we are on safe ground in saying that many parts of the globe, now barren, were still comparatively densely forested within historical times. While climatic changes may have initiated the disappearance of the forest, man by persistent deforestation has certainly aggravated matters.

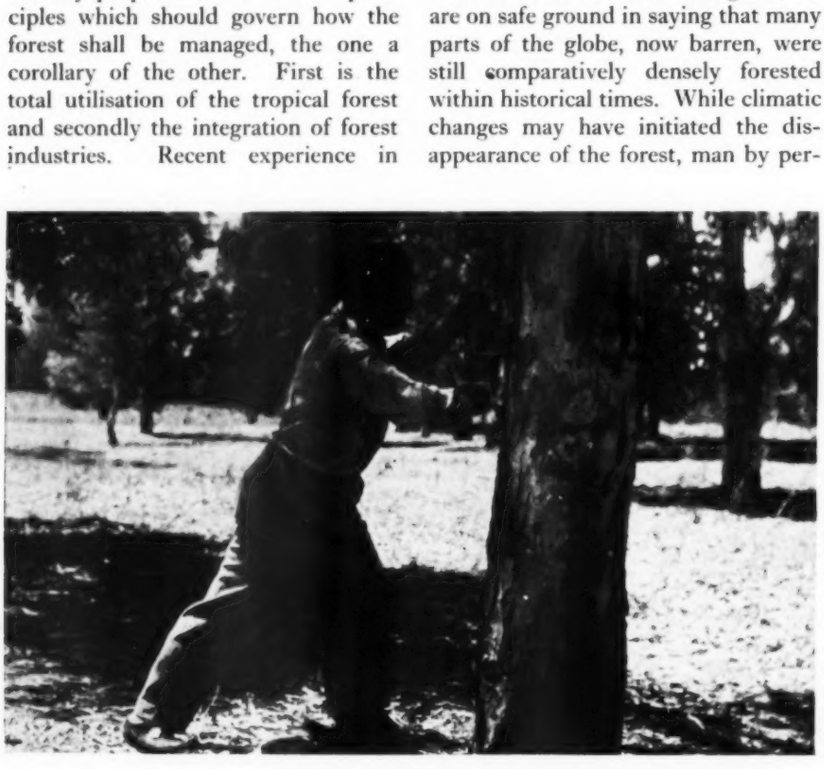
Foresters and conservationists are well aware of this fact, but it still needs to be repeated to prevent mistakes by laymen who, as officials, must decide on high-level forest policy.

Perhaps we may put it as follows: although certain extreme climatic conditions leading to the formation of actual deserts cannot be considered as initially caused by man, the aggravation and advance of these conditions is certainly to be attributed to him. While it may not be prudent to envisage radically changing such conditions through forestry measures alone, it is essential for the forester to counteract directly the actions by man that have conduced and still are conducing to the encroachment of the desert.

In this way, we limit the scope of the forester's responsibility; to define it more accurately we may run over the many services rendered by the forest, or rather that can be rendered by new forests, in arid zones.

The main interest lies in the part they play in protecting the soil, particularly against desiccation and intensive wind erosion. The effect on moisture exchange between air and soil is also far from negligible, particularly when the plantations form a compact extensive block rather than scattered units, although admittedly such influence is local.

The interplay between the forest and the rural communities is just as great as in the humid tropical regions. Forest clearance is one of the chief ways in which man aggravates extreme climatic conditions, makes agriculture difficult and favours the spread of desert conditions. The forests in the parts of the dry zone with relatively good rainfall, which are the areas best for agriculture, are those most gravely threatened; the pace of shifting cultivation tends to quicken and very soon natural regeneration of the existing forest becomes impossible. It is here that thorough investigations of remedial action must be made and protective measures taken to halt or limit malpractices in the interests of the local inhabitants. It may in many cases be necessary to change entirely the local economy if total ruin of the still existing forest areas is to be averted.



Mr. J. Moser, the FAO forestry expert in Libya, measuring with an increment bore the rate of growth of a *eucalyptus camaldulensis*

The wetter regions merge into the dry, arid and pre-desert zones with their special steppe type vegetation and these are the domain especially of graziers and nomadic herds of livestock. The use of these typical forest range areas confronts the forester with technical, social and often even political problems.

Finally, the open woodlands or savanna forest in arid areas have always some economic value which in itself is an incentive to their thoughtless destruction. The forester must arrange to meet local needs for timber and fuelwood without risking the disappearance of the trees.

Perhaps we may sum up as follows: Forest and woodlands in dry, arid and sub-desert regions must be resistant to extremes of climate and to the action of man. It is precisely this which is technically difficult and very expensive. Remedial measures should always be on a large scale and in accord with long-term policy framed with due regard to the many potential services of the forest. The effect of forest on local climate is limited; therefore, in improvement works one must, near areas of permanent cultivation, deal in very extensive areas according to preconceived plans; and the agricultural economy must, if necessary, be reshaped to permit proper protection of forest and range.

In view of the technical difficulties and the costs involved, the various operations must be performed as economically as possible—they should take the form of broad protection measures or very elementary silviculture. In afforestation, inexpensive methods adapted to extremely dry regions must be employed; methods commonly used in temperate climates, with or without irrigation, can only be practised in special circumstances, chiefly to meet particular industrial needs.

Forest research in the tropics

Whether in the wet or dry tropics, there are two types of problem with which forestry is confronted.

The object of forest research is to solve the technical problems and this is comparatively easy to do with good organisation, well - planned programmes and able research workers, although there is a difficulty in seeing that research does not wander off into the abstract. The goal of forest policy and management is still in many cases not well defined, so that it is not always easy to set the tasks for research. Some research must, of course, precede planning, but research is most needed to gauge future possibilities. It must relate, therefore, to properly formulated programmes. Here we see the need for a definite tie between planning and research.

Tropical forestry raises new, vast and complex aspects of science. The diversity of the problems to be solved has led to advocation of world co-ordination and centralisation of research in order to eliminate duplication of effort, and expedite and improve the quality of the work. This idea, which is an application on a world scale of the now accepted principle of the utility of regional research, is certainly attractive and should not be rejected outright, but there are serious drawbacks to directed research.

The value of regional research lies in the fact that some investigation relating to a specific ' subject ' can readily be centred for any given region. For the tropics as a whole, however, even where conditions of soil, climate and altitude are comparable, different economic, social and political backgrounds distort the picture. Forest research can hardly be conducted in Puerto Rico for application in parts of New Guinea because the whole concept of forestry is different in the two environments. Such difficulties are not insuperable, but they do lessen the degree of world centralisation possible.

Highlights of tropical forestry

This paper in no way attempts to be a scientific analysis of the difficult problems facing tropical foresters. Its purpose is to ' think out aloud ' and give some order to certain facts and principles.

A forester not conversant with tropical conditions may regard what we have said as neither particularly original nor apt only to the tropics. This is, indeed, correct and goes some way towards answering the question raised at the beginning as to whether tropical forestry should be regarded as a separate discipline. But the points and principles we have raised bear reiteration because they stand out as highlights in the experience of all whom FAO has consulted on the subject of tropical forestry. Tropical forestry should be seen not as some strange and awesome subject, but as a matter to which all foresters can make commonsense contributions.

Photos : United Nations Information Centre, London.

Shell Research Company

A new company—Shell Research Ltd.—is being incorporated to take over the research assets and activities in the United Kingdom of the Royal Dutch/Shell group of oil companies formerly handled by the Shell Petroleum Co. Ltd. The new company will, therefore, assume control of Thornton research centre in Cheshire and Woodstock agricultural research centre in Kent.

The work of Shell Research Ltd. will be co-ordinated with other research activities carried out by the Royal Dutch/Shell Group of oil companies in the Netherlands and in the U.S.A. Mr. H. Bloemgarten will be chairman of the board of the new company and Dr. C. G. Williams will be director and general manager.

Research was carried out by Shell before the war in both Holland and America, but it had its real beginnings in the United Kingdom in 1940 when an aero engine laboratory was constructed at Thornton. From 1944 onwards additional laboratory facilities were added, so that, at the present time, research on a wide range of fuel and lubricating oil products, on bitumen, and on chemicals derived from petroleum, is being carried out at Thornton. The staff numbers about 850, and Thornton is probably the biggest and best equipped laboratory in the world for studying applicational problems on oil products, not only for the United Kingdom market, but also for marketing areas abroad.

In addition, there is at Woodstock in Kent an experimental farm with associated laboratories—now in the process of being extended—which undertakes the development of agricultural chemicals, such as fungicides, weedkillers and insecticides, for world-wide application.

The Soilless Cultivation of Vegetables in India

J. W. E. SHOLTO DOUGLAS, B.Sc., Dip.Ag.

Interest in the soilless cultivation of vegetables continues to grow. It is gaining considerable extension in India and other places. The following paper presents details of its development under Indian conditions.

DURING recent years, a considerable amount of publicity has been given to the results achieved with different methods of soilless cultivation of plants. Although only 25 years have elapsed since the first large-scale experiments in hydroponics were undertaken by Gericke,[1] in California, where the brilliant sunlight and equable climate make for almost perfect conditions, the rate of progress of the new techniques has been most encouraging. A general survey of the position up to and including 1952 was printed in the issue of WORLD CROPS for June of that year.[2] There are now few persons who will not be familiar with the broad outline of soilless culture, and of the basic principles upon which it is founded. Unfortunately, however, despite the care and forethought that have been given to evolving different systems of growing plants without soil and the ingenuity displayed in applying theory to practice in many localities, there has been hardly any attempt to utilise hydroponic techniques on a large enough scale to effect significant increases in food production in the areas where extra nourishment is most needed, such as the over-populated regions of Southern Asia.

Potentialities of hydroponics

It has been contended that multiple cropping and intensive culture by hydroponic means could effect profound changes in the social life of the world. Great cities could be made self-supporting and freed from fear of starvation.[3] Be that as it may, an effort has been made in India to introduce hydroponics as a popular method of growing vegetables. Early trials initiated in the autumn of 1946 resulted in devising a novel system of soilless cultivation, simpler in practice than any of the techniques which have proved successful in occidental countries.[4] In fact, it is not incorrect to say that the main reason for the rapid spread of this new Indian method—termed the Bengal system of hydroponics—is its simplicity, while it can, in fact, be easily adapted and modified for use in any place.

The devising of a system of soilless culture suitable for general use in India depended on a number of factors. The various methods practised in Britain and America are unsuitable for various reasons, in particular the elaborate and expensive apparatus required. In 1946, it became obvious to the personnel of the newly established hydroponic research unit, set up at the Government of West Bengal's experimental farm at Darjeeling, that a new system, of which practicability and simplicity must be the keynotes, would have to be introduced if soilless culture was to succeed in Bengal. One of the problems was that of the Asiatic monsoon, which could easily upset other methods. Eastern India lies between the latitudes 20° and 30°N and seasonal rainfall is very heavy. At Kalimpong, near Darjeeling, where the experimental station is located, the rainfall for July is seldom under 32 in., while for the whole year the average is 95 in. Calcutta is very similar, and not far away is Assam, with in places over 300 in. per annum. Techniques with impressive records of achievement in the United States had failed miserably when tried out under European conditions,[5] while it is not easy to obtain apparatus, such as electric time clocks, flumes, or watertight solution tanks, in isolated places.

In spite of these drawbacks, there were certain advantages. Labour is readily obtainable at low cost in India. Moreover, it was found that certain indigenous materials could be utilised quite satisfactorily in place of highly priced imported products, and with a little ingenuity and improvisation many such substitutes have, in fact, been employed. At the start, the complicated systems of Gericke, Withrow and Mullard were rejected and attention concentrated upon the development of simplified methods which would be easy to maintain, inexpensive to install and economical to operate.

Installations in Bengal

In the autumn of 1946 the first hydroponicum was installed at Kalimpong, in the Darjeeling district of Bengal. It was situated at an elevation of 4,000 ft. above sea level in the foothills of the Himalayas. Kalimpong is an ideal site for growing all types of plants. The main meteorological data for 1946 to 1947 are as follows:

TEMPERATURE

Year	*Month*	*Maximum*	*Minimum*
		°F.	°F.
1946	October	79	58
	November	73	50
	December	66	49
1947	January	62	45
	February	66	50
	March	74	52
	April	80	54
	May	83	60
	June	81	63
	July	80	67
	August	81	68
	September	81	67

RAINFALL

Year	*Month*	*Rainfall in inches*	*No. of rainy days*
1946	October	4.34	10
	November	0.32	1
	December	Nil	Nil
1947	January	0.12	1
	February	Nil	Nil
	March	2.49	10
	April	2.49	6
	May	5.29	11
	June	10.30	18
	July	32.70	29
	August	17.85	20
	September	14.22	19

The method

In the method of soilless cultivation adopted at Kalimpong the plants were grown in troughs constructed from suitable material and filled to a depth of 8 in. with a coarse mineral aggregate, preferably a mixture of about five parts of gravel, rock chips or cinders of $\frac{5}{8}$-in. to $\frac{1}{4}$-in. grade and two parts of sand. Nutrient salts, in the form of chemicals, or as synthetic resins, were applied dry at defined rates to the surface at regular intervals. In the case of the salts, application was made by even sprinkling between the rows of growing plants, followed by watering with a light spray of water. In the periods between one feeding to another normal waterings were given in the dry season, but during the monsoon reliance was placed on the rainfall. No elaborate equipment was utilised, nor were completely waterproof troughs needed.

Types of trough

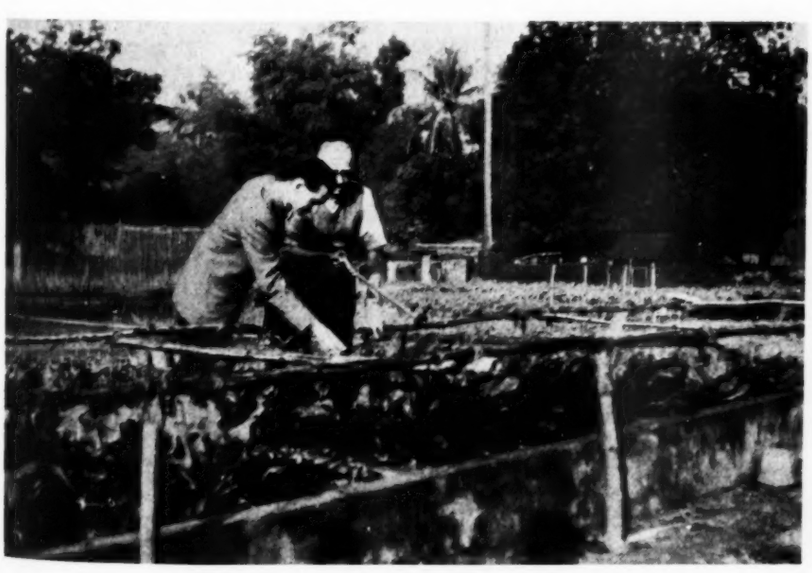
Three types of troughs were built initially: (*a*) small wooden construction (*b*) beds with non-erodable plaster side walls on a concrete base, and (*c*) containers made from stone and concrete. Plaster walls require some support in the monsoon time with lattices of bamboo or wood. All these types proved satisfactory, but a hydroponic trough may be made from wood, concrete, asphalt-impregnated mats, iron or steel, plaster or bricks and mortar; in fact, almost anything but galvanised material, this last named being toxic to plants. If galvanised sheeting has to be employed, it should be given a coat of bitumen emulsion to prevent zinc entering the cultural solution. Wooden beds must be strongly built and if coated with asphalt paint to prevent rot will last longer. Cement or bricks are particularly suitable for town use, while metal troughs, though expensive, are permanent and portable.

It is essential to insulate iron and steel apparatus by a thin encasement of plaster to prevent undue heat radiation. In most cases a form of mud plaster devised by the Director of Irrigation Research, Lahore, Punjab, will probably be suitable.* The method of constructing hydroponic beds from this plaster, which was found satisfactory, was first to erect the base and framework in skeleton form, with large stones placed end to end; successive coats of plaster are then applied to make a symmetrical and solid structure. Beds should not be over 4 ft. wide, to allow easy access to the plants, and of any convenient length. For general purposes, side walls 8 in. high and from 2 to 4 in. thick are satisfactory. It is a good thing to have the base slightly cambered and small drainage holes fitted with plugs provided at regular intervals in the side walls.

*The method of making this non-erodable mud plaster is as follows:

The following quantities of material will be required to cover an area 1,000 sq. ft. with a plaster 1 in. thick: 75 cu. ft. of earth, 25 cu. ft. of sand, four bags of cement, 5 to 8 maunds (1 maund = 82 lb. avoirdupois) of straw and 20 lb. of sodium carbonate.

Dissolve the sodium carbonate in sufficient water to soak 5 to 8 maunds of straw, add earth and work up. Leave for a week, working up daily, and adding water to replace evaporation losses. After a week the soil will have dispersed completely and the straw be well rotted. Mix thoroughly four bags of cement and add to the other ingredients; work all up to suitable consistency. Apply as plaster.



A hydroponic trough, Bengal system. The top frame is to hold matting shades in very hot weather

Drainage

Drainage varies according to the type of material used. In concrete and metal troughs it is safe to rely almost entirely on outlet channels to prevent waterlogging and to allow proper aeration. With plaster not only is an automatic supply of oxygen guaranteed by the percolation of excess moisture through the semi-porous walls (and consequent intake of air from above), but immoderate saturation of the aggregate is unlikely. However, to guard against heavy monsoon rainfall, drainage pipes are needed even in plaster troughs to remove superfluous water rapidly. A small gutter is built around the base of each wall to carry away seepage, which may be collected in a sump and re-used. Shade during very hot periods is provided by matting supported on 6-ft. poles with cross pieces over the troughs. The object of such tall screens is to enable morning and evening sunshine to be admitted to the plants, but to exclude the noonday glare when the sun is directly overhead. The mats also afford protection from very heavy rain and hail. The screens also help to maintain a reasonably low temperature in the aggregate. Temperatures of over 90°F. are not desirable, since they lead to excessive transpiration, wilting and permanent damage to plant tissues.

Filling the troughs

As soon as troughs are completed, they are filled to a depth of 8 in. with the aggregate. In the first trials a mixture of rock chips and sand as detailed above was used. Mountain boulders broken up with large hammers produced an aggregate of the required proportions. The chemical analysis of this growing medium was:

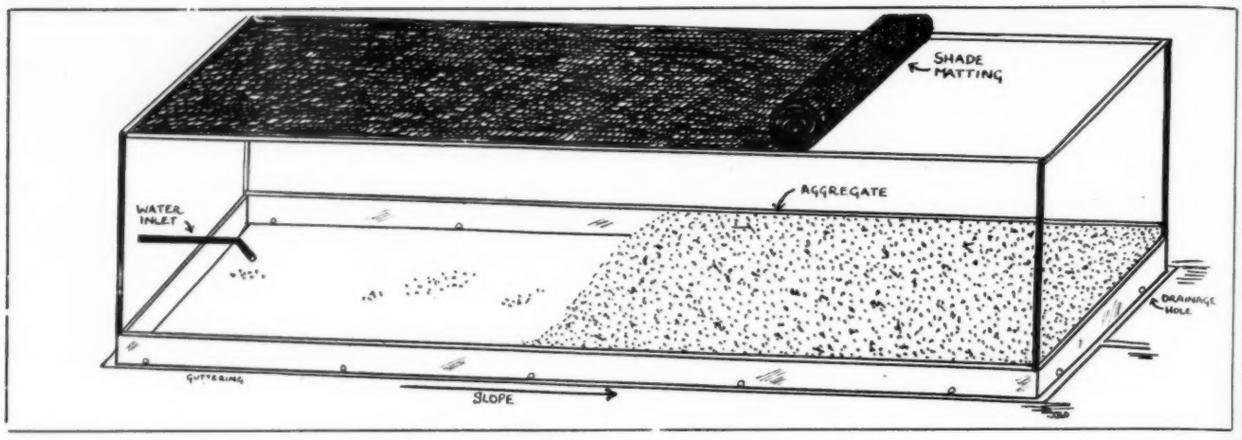


Diagram of a hydroponic trough, Bengal system

ANALYSIS ON SAMPLE DRIED AT 100°C.

	%
Silica (SiO_2)	60.65
Alumina (Al_2O_3)	15.98
Oxide of iron (Fe_2O_3)	9.14
Titanium oxide (TiO_2)	0.70
Phosphoric acid (P_2O_5)	0.18
Lime (CaO)	1.50
Magnesia (MgO)	1.62
Potash (K_2O)	4.22
Soda (Na_2O)	1.65
Loss on ignition	4.24
Undetermined	0.12
	100.00

SOLUBLE IN 1% CITRIC ACID (AVAILABLE)

	%
Phosphoric acid (P_2O_5)	0.024
Potash (K_2O)	0.022
Lime (CaO)	0.045
Magnesia (MgO)	0.052

It is of interest to compare the above aggregate with that utilised in experiments in soilless culture by Templeman and Pollard at Jealott's Hill Research Station,[6] the analysis of which was as follows:

	%
Water	0.14
Silica	98.43
Alumina	0.48
Iron oxide	0.70
Lime	Nil
Magnesia	0.14
Alkalis	0.11
	100.00

Experience has shown that an appreciable quantity of the potassium in the Kalimpong aggregate goes into solution. A medium should never have a high calcium content, or precipitation of phosphates from the nutrient mixture may occur. However, if the use of calcareous material is unavoidable, it should first be leached for a week with water containing sulphuric acid; the same technique is also recommended for cinders. Eastwood considers that an overnight soaking is adequate. The same authority has corrected excess acidity by flushing with sodium hydroxide solution.[7]

Subsequent treatment

The growing medium used in these experimental beds has now been continuously cropped for over eight years. Periodical disinfection of the troughs has been carried out by flushing them through with a solution of 1% formaldehyde, followed by fresh water on several successive days. The incorporation of copper sulphate in the wash water has been found to prevent the growth of algae and fungi in the beds, and partly for this reason it is always added to the nutrient formulae. An aggregate may not always be entirely inert and in such cases it is desirable to find out what element is being given up. Several useful growing media are now available, including vermiculite, collite, haydite and pebble phosphate rock. When using the Bengal method it is recommended whatever local aggregate may be available should be used, provided, of course, that it contains no toxic material, but the ratio—five parts of coarse material to two parts of fine material—should not be deviated from if successful results are to be obtained.

Equipment needed

The method requires few appliances. For irrigation, rubber hose, metal or wooden guttering, or watering cans are used to convey water to each bed. No tanks are needed, as the water is piped straight from the source. A stirrup pump is ideal for washing in the nutrient salts after application. The fertiliser mixture can be sprinkled over the troughs by hand, but a simple spreader, cone-shaped with a number of small holes at the apex, speeds up the work. In use it is inverted and gently shaken. To facilitate even flow, sand may be incorporated with the fertiliser. A pair of scales or a spring balance is necessary for weighing chemicals. Apart from these, no other equipment is required, except certain tools of normal horticultural practice, such as rakes, small forks and dibbers.

Water supply

A good and reliable water supply is essential. This must be regular and reasonably clean. The analysis of the water used in the original trials is given here:

Appearance: Clear. Sediment: Nil.
Odour: Nil. Reaction: pH value 6.6.

RESULTS EXPRESSED IN PARTS PER 100,000

Analysis	
Total solids dried at 100°C.	15.12
Alkalinity calculated as:	
Calcium carbonate	2.80
Silica (SiO_2)	0.48
Oxides of iron and alumina	0.16
Lime as CaO	1.34
Magnesia (MgO)	1.08
Sulphates (SO_3)	0.07
Chlorides (Cl)	3.19
Phosphates (P_2O_5)	0.25
Potash (K_2O)	0.76
Nitrates as N	0.75
Free carbonic acid	0.68

The above is a typical water supply as found in South-East Asia and the analysis is interesting inasmuch as an appreciable quantity of nitrates are present which may be utilised by the crops in the hydroponic beds. Templeman and Pollard (1947) reported that the water used for hydroponic culture at Bracknell had a pH of 7.7, which they corrected to 6.0 before spraying it on to the beds.[8] Salinity of water

intended for hydroponic cultivation should not exceed 2,500 p.p.m.

Water consumption

The rate of water consumption varies considerably according to local climatic conditions. At Kalimpong it was found that a trough of 1,000 sq. ft. required 200 gal. *per diem* to keep it moist during the dry season, with daily temperatures of up to 80°F. average. In Calcutta, although hot season temperatures are, on the whole, about 20°F. higher, the climate is humid and water consumption is not appreciably greater, 1,000 sq. ft. of trough space calling for 350 to 400 gal. every day. Losses by evaporation can be checked by good shading. This compares favourably with soil requirements in India, where twice daily waterings are needed in the hot dry times in horticultural work, averaging 1 gal. per sq. ft. of soil surface.

Nutrient mixtures

Several hundred different chemical mixtures have been proposed for hydroponic use; it was found in Bengal that the actual choice of salts is immaterial provided a supply of the necessary elements and a satisfactory equilibrium is assured and maintained. In practice, cost and availability will be the chief factors in making a selection. The following mixtures of nutrient salts of fertiliser grade chemicals have been used all over India and have given good results. They should be kept dry in storage and be well mixed before application.

1. For the Dry Season

	oz.
Nitrate of soda	5
or	
Sulphate of ammonia	4
Calcium sulphate	2
Superphosphate	3
Potassium sulphate or muriate	1½
Magnesium sulphate	2½
Trace elements	¼ dr.

2. For the Monsoon

	oz.
Nitrate of soda	5½-6
or	
Sulphate of ammonia	5
Calcium sulphate	1½
Superphosphate	2½
Potassium sulphate or muriate	2½
Magnesium sulphate	2
Trace elements	¼ dr.

These formulae are applied at the rate of 2 oz. weekly or every 10 days per square yard of trough surface space. Trace element mixture consists of:

	dr.
Zinc sulphate	3
Manganese chloride	9
Boric acid powder	7
Copper sulphate	3
Iron sulphate	10

The Bengal methods of hydroponics call for the dry application of the nutrient mixture in most cases for the sake of simplicity. However, satisfactory results were also obtained by dissolving the mixture in water before use and applying as a liquid.

Experience has shown that a variation of a few grammes either way in weight of a particular chemical makes no difference in a large outdoor hydroponicum.[9] The frequency of application changes with the climatic conditions. It is necessary to apply nutrients more often in the rainy season. Normally in Bengal the brilliant sunlight enables potassium to be cut by 50%. During the monsoon, on the contrary, a maximum concentration of this element is needed.

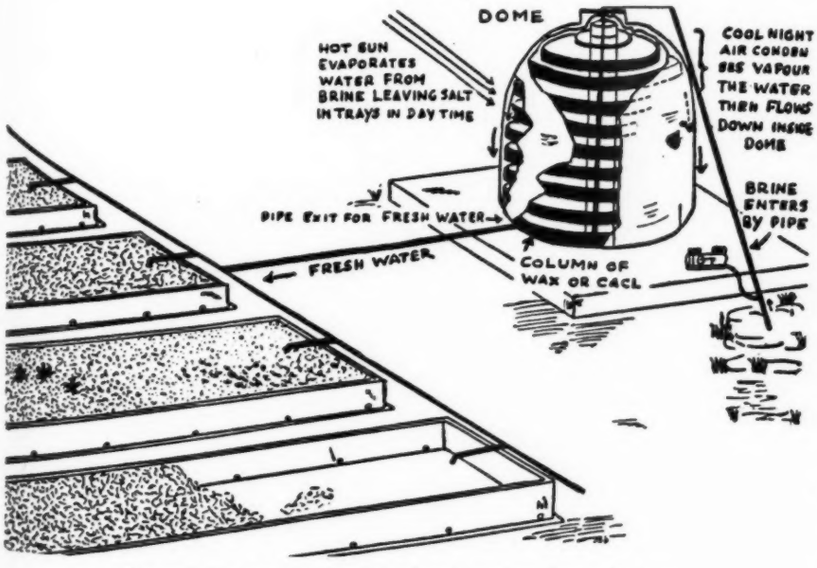
Use of synthetic resins

Work has also been undertaken with synthetic resins supplying plant nutrients in adsorbed form. The advantages of using amberlites include the fact that sufficient nutriment may be incorporated in the media at the beginning of the season to last all through the crop growth period, only water being necessary. This obviates the frequent use of fertilisers. Many of the complications of nutrient management are eliminated, there is reduction of losses due to leaching during rainfall, and there is the possibility of varying single ion concentration with simultaneous variation in ions of opposite charge. Depending on the preparation, amberlites have either anion- or cation-exchange properties.

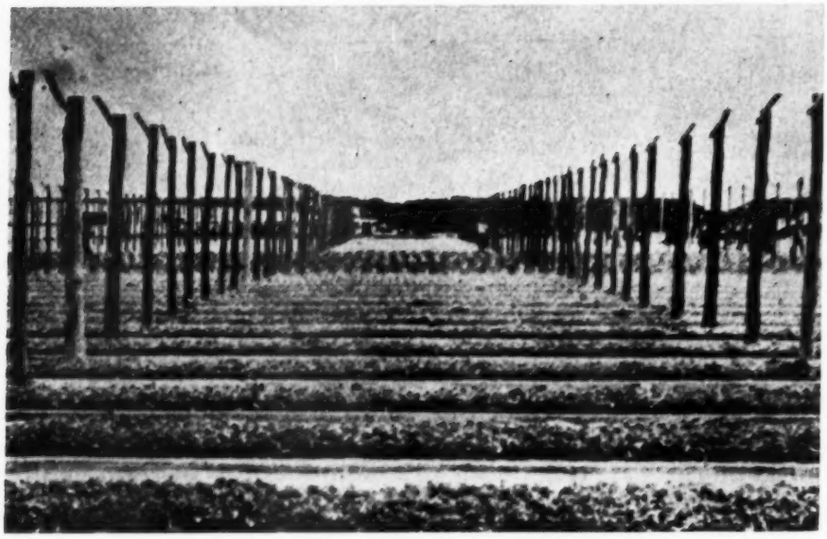
It was found that the use of a KNO_3 solution as the source of potash and nitrogen, with consequent omission of potassium- and nitrate-amberlites from the beds, reduced adverse contact effects. Further investigation continues, but the results so far indicate that synthetic resins may have a promising future in hydroponic culture, and the research organisation in India is already recommending the more advanced amateur growers to make trial use of them.

Practical operations

In some cases seeds are sown directly on the aggregate, but experience has indicated that the best results are obtained by germinating those with a diameter of under ¼ in. in separate boxes containing sand or some other inert medium and transplanting the seedlings when a height of 3 to 4 in. has been attained. Cereals and legumes are not, of course, transplanted and must be spaced out properly in the beginning. Before sowing the medium is brought up to the correct degree of saturation. No flooding is permitted, the aim being to keep the growing medium constantly moist like a sponge that has just been lightly wrung out. The importance of this cannot be too


DOME
HOT SUN EVAPORATES WATER FROM BRINE LEAVING SALT IN TRAYS IN DAY TIME
COOL NIGHT AIR CONDENSES VAPOUR THE WATER THEN FLOWS DOWN INSIDE DOME
BRINE ENTERS BY PIPE
PIPE EXIT FOR FRESH WATER
FRESH WATER
COLUMN OF WAX OR CACL

Apparatus for producing fresh water from brine



Hydroponic units growing lettuce, British Guiana

strongly emphasised. No seeds should be sown at a depth of more than 2 in. For tomatoes and other small seeds ¼ in. is ample. All crops have to be grown in straight rows parallel to the width of the bed so that the nutrient salts may be applied without difficulty. Plants invariably establish themselves immediately; there is no wilting. Chemicals should never be allowed to fall on the crop foliage. Periodic pH checks are undertaken of the moisture present in the aggregate. This automatically takes into account the acidity or alkalinity of the solution that the plants are feeding off; pH values are best maintained between 6.0 and 6.5, although for some crops, such as potatoes, a lower reading is more advantageous. For practical work, a B.D.H. universal indicator gives good results. Normal techniques of staking and spraying are necessary and intercropping in soilless cultivation is extensively practised to save space and increase yields.

Cropping results

A few of the results from last season's work in Bengal are given below (Table 1).

Cost of operating

It has been found that the cost of maintaining an acre of hydroponicum on the Bengal system in India averages £2 10s. 0d. *per mensem*, excluding casual labour for harvesting. Installation charges range between a few pence and 1s. 6d. per sq. ft., according to the materials used.

Conclusion

The Bengal system of soilless cultivation has succeeded in so simplifying hydroponics that it may be used as a practical means of food production. The great interest that has been aroused in growing plants without soil since the announcement of the results of the work conducted at the Government of West Bengal's experimental station at Kalimpong, and the subsequent extension of hydroponics throughout India, augurs well for the future.

The advantages of soilless cultivation according to the Bengal methods include considerable reduction in growing area, much higher yields in regions of poor soil, relative freedom from soil diseases and very consistent crops. Weeds are no problem, growth is quicker, there is no dirt, waterlogging never occurs, heavy toil is eliminated and labour economy is considerable. Costs compare favourably with soil culture. Hydroponics may be used where ordinary horticulture is impracticable.

Soilless cultivation is intended to supplement, not to displace, soil as a food-producing agent. For field crops, such as cereals or roots, soil will always be supreme. Hydroponics is most valuable in vegetable growing and could make urban or industrial centres self-supporting in vegetables, as well as enabling good crops to be produced in deserts or barren localities.

TABLE 1

Tomato (*Lycopersicum esculentum*), var. Darjeeling.	Average of 16.8 lb. per plant in a 1,000 sq. ft. trough.	Picking commenced on the 90th day after sowing and ended on the 166th day. The yield of marketable fruit only was recorded, but in addition 'chats' averaging about 10% of the crop were obtained. Individual tomatoes weighed up to 14 oz. each.
Lettuce (*Lactuca sativa*), var. Wayahead.	403 lb. from 1,000 sq. ft.	Plants ready for consumption in 35 days.
Maize (*Zea mays*), var. Red Round.	7,063 lb. of grain from 1 acre.	Ready for harvesting on 76th day.
French or kidney beans (*Phaceolus vulgaris*), var. Dwarf.	507 lb. from 1,000 sq. ft.	Picking commenced on the 38th day after sowing.

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Photos: P. 57, Agricultural Institute, West Bengal, p. 60, Reinhold Pub. Corp.

To Authors and Readers

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Cotton Production in the British Commonwealth in 1953

The following account of cotton production in the British Commonwealth and the Sudan, excluding India and Pakistan, is condensed from the Annual Report of the British Cotton Growing Association, to which acknowledgment is made.

TABLE 1 gives the estimated production of cotton in the British Commonwealth and the Sudan (excluding India and Pakistan) for the years 1946 to 1953 inclusive in bales of 400 lb. each.

The increase of 26,000 bales in the total production, compared with the previous season, is accounted for by the large crop of Sakel and Sakel type cottons in the Sudan, which is over 160,000 bales more, but offset by decreases in American type cotton production in the main growing countries of East, Central and West Africa.

The position in various countries is briefly summarised below.

The Sudan

Total production was some 150,000 bales higher than in 1951-52, being estimated at approximately 463,600 bales. This is the second largest crop ever produced, the record being 526,600 bales in the 1950-51 season. The whole of the increase was in Sakel and Sakel type cottons, for which there was an increase in the area of over 55,000 feddans, and these crops amounted to approximately 401,600 bales, a considerable improvement on the previous season's production of 239,943 bales. However, despite average or above average yields, the season was in some ways disappointing; poor grades and falling cotton prices meant lower cash returns as crop establishment costs had been heavy, due to heavy weed growth and high labour rates following the big cotton prices of the previous years.

In the Gezira irrigated area, and the White and Blue Nile Pump schemes, growth of cotton was good, although crops had to contend with heavy weed growth following good rains at sowing time. Asal, a stickiness on leaves and bolls caused by aphis, caused some shedding, but white fly and later bollworm attacks were severe. The winter was unseasonably warm and this, with the heavy attacks of white fly, caused early and concentrated flowering, and bolls from all parts of the plant opened at the same time—the usual higher grades in the first pickings from the lower branches came in with the cotton from the upper branches. Grades generally were poor.

Spraying was general in the Gezira, and on private and Government schemes along the Nile, aeroplanes and tractors being used. An interesting development has been the increasing use of knapsack sprayers by the smaller cultivator, to whom the benefits of spraying have become apparent.

Regarding areas under flood irrigation: in the Tokar Delta the Baraka flood was better than in the previous

TABLE 1

	1946	1947	1948	1949	1950	1951	1952	1953
Anglo-Egyptian Sudan:								
Sakel type	237,900	278,300	263,300	316,700	334,400	490,000	240,000	401,600
American type:								
Irrigated	2,700	2,300	3,500	4,600	5,600	5,900	9,500	8,400
Rain-grown	1,800	1,800	10,200	19,000	20,000	30,700	63,400	53,600
Total Anglo-Egyptian Sudan	242,400	282,400	277,000	340,300	360,000	526,600	312,900	463,600‡
East Africa:								
Uganda	227,900	232,200	170,000	391,000	340,000	346,500	380,200	320,000
Tanganyika	41,100	40,000	53,800	51,300	49,700	47,500	79,200	49,300‡
Kenya	5,100	5,200	4,900	9,800	8,000	13,800	16,500	9,400
Nyasaland	9,100	11,200	13,700	2,200	10,700	4,150	12,500	15,900
Total East and Central Africa	283,200	288,600	242,400	454,300	408,400	411,950	488,400§	394,600
Nigeria:*								
Northern	34,500	34,600	21,700	51,100	61,200	76,400	113,400	95,500
Southern	2,800	50	100	50	1,100	200	100	300
Total Nigeria..	37,300	34,650	21,800	51,150	62,300	76,600	113,500	95,800
West Indies	3,800	2,600	3,900	6,700	5,600	6,100	5,800	4,200
Southern Rhodesia	850	400	700	2,100	5,100	4,100	9,500	3,100
Union of South Africa ..	350	1,100	2,700	5,200	7,000	13,800	35,000	23,100
Australia	2,800	2,000	1,800	700	1,000	1,400	1,900	5,200
Sundries	2,000	2,000	2,200	3,000	7,000	10,300	10,500	14,000†
Grand Total	572,700	613 750	552,500	863,450	856,400	1,050,850	977,500§	1,003,600

*Purchased for export only.
‡Estimated.
†This includes Aden 10,400 bales and Cyprus 3,000 bales.
§Revised.

seasons, but of 39,000 feddans sown to cotton 12,000 feddans were wiped out by severe hababai (north - easterly winds), which were the worst experienced for many years. The established area being thus 27,000 feddans, pests and diseases were light. The crop recovered with cooler weather and reached 9,600 bales; in the previous season it was only 5,660 bales. In the Gash Delta (Kassala) there was a considerable increase in the area under cotton. The Gash flood was heavy and well distributed, in spite of heavy spates which made it difficult to control, but 70,000 feddans were sown. A good growing season was experienced and in the early part a record crop was expected, but Sudan bollworm ravaged the crop and a good deal of cotton was lost; production was some 26,300 bales, compared with 16,463 bales in 1951-52.

Production of American type cotton, both rain-grown and irrigated, was somewhat lower than in the previous season, being approximately 62,000 bales, compared with 72,943 bales.

Uganda

Cotton production in 1952-53 was 320,016 bales, compared with 380,163 bales in the previous season; it is the smallest crop since that of 1947-48.

The off-take of seed and the preparation of land for the crop were satisfactory, but planting was delayed by dry weather in June and July and, in consequence, an abnormally high proportion of the crop was late planted. Favourable planting conditions in August enabled a satisfactory acreage to be planted in all areas and a continuance of these conditions in September permitted further planting during the first week of that month.

The price paid to the growers was 50 cents per lb. (100 E.A. cents=12d.) for BP52 (the best grade) and 48 to 50 cents, according to the district, for the other grades.

The marketing season started in all provinces in the first week in January; buying was very heavy during the first few weeks and was completed in most districts in March.

The exports and f.o.b. Mombasa values for 1953 and the two previous years are shown in Table 2.

Of the quantities exported in 1953, 175,900 bales were shipped to India, 13,900 to Japan and 13,700 to Hong Kong; 39,200 bales came to Great Britain, whilst Germany took 38,700 and Holland 11,260 bales.

Picking over seed cotton before marketing in Nigeria

TABLE 2

Year	*Bales*	*Values*
	£	£
1951	346,281	28,840,331
1952	379,769	29,698,000
1953	308,551	15,964,396

Tanganyika Territory

The cotton crop harvested in 1952-53 season, estimated at around 49,250 bales, shows a considerable drop from the record crop of the previous season of 79,171 bales.

Production figures for the four provinces for 1953 and each of the three preceding years are shown in Table 3.

Kenya Colony

The cotton crop in the 1952-53 season was seriously affected by unfavourable weather conditions and attacks by insect pests and was considerably less than in the previous season, being just under 9,500 bales, compared with 16,500 bales in 1951-52.

Table 4 shows the production figures for the past three seasons.

Nyasaland

Cotton production in 1953 again showed a considerable increase, the crop amounting to 15,854 bales (400 lb.). This figure has only been exceeded twice, *viz.* in 1935 by the record crop of 21,000 bales, and 17,350 bales in 1938. Of the 1953 crop, 14,280 bales were grown by African farmers on their Trust Land gardens, the remaining 1,574 bales being grown on private estates. The satisfactory result in 1953 is largely attributable to the policy of the Agricultural Department in encouraging early planting and prohibiting mixed cropping.

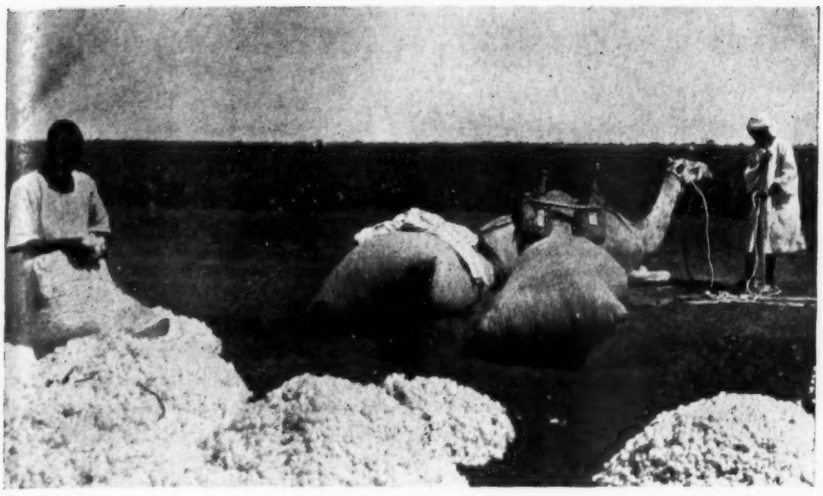
TABLE 3

Province	1950	1951	1952	1953*
Lake	38,905	42,349	70,299	38,384
Eastern	8,433	3,047	6,723	8,220
Northern and Tanga ..	2,205	1,923	1,970	2,400
Southern	172	145	179	250
Total	49,715	47,464	79,171	49,254

*The 1953 crop outturn is not yet finalised, and the figures are estimated.

TABLE 4

	1952-53	1951-52	1950-51
	Bales	*Bales*	*Bales*
Naanza Province	7,951	12,058	8,594
Coast Province	1,460	4,435	5,230
Total	9,411	16,493	13,824



Seed cotton awaiting transport to a Sudan Gezira Board ginnery factory

Purchases amounted to 1,170 tons of seed cotton, equal to 1,945 bales, about the same as in the previous year.

In the Northern Province, where the crop is planted and harvested at a different period from that in the other two provinces, a record crop of 950 bales was harvested, compared with 700 bales in the previous year.

Damage by red bollworm attack was slight in the Lower River area of the Southern Province, but was heavy in some higher areas; in the Central Province attacks from this pest were confined mostly to the Dowa district. Red stainer attacks were worse than usual, and this, combined with anthracnose (a fungus disease), resulted in a high proportion of second grade lint.

Nigeria

The quantity of cotton purchased for export in 1953, *viz.* 95,758 bales, was considerably below that in the previous year, when there was a record outturn of 113,510 bales.

Seed (improved Allen 26C) distributed for planting was 12,924 tons, representing an increase of 1,837 tons over the former record distribution in 1951; the acreage planted also increased. In addition, 303 tons of Benue Ungraded seed was distributed in Benue and Kabba Provinces.

The guaranteed prices to the growers for their seed cotton at all markets, announced before planting time, remained the same as last year, *viz.* Grade 1 Allen cotton, 6d. per lb.; 5.8d. for Grade 2, and 5.4d. for Grade 3. For Benue cotton the price was maintained at 5.5d. per lb.

Poor rains at planting time meant that a large percentage of the crop was late planted, and while for a time growing conditions were favourable, heavy rains in September and the first few days in October, followed by an early cessation of the rain and an early advent of the Harmattan, combined to reduce the yield.

The main areas affected were Southern Katsina and the Sokoto Province, where production decreased considerably. The Zaria Province, Northern Katsina and the Kontagora Division of the Niger Province were not affected to the same extent, but did not produce as well as earlier anticipated. The increases in the other provinces were due to the larger areas planted.

NA cotton was purchased at 179 markets, compared with 160 in 1951-52.

The quantities purchased for export in each province in the north are shown in Table 5 (1951-52 shown for comparison).

TABLE 5

Province	*Bales of 400 lb.*	
	1952-53	1951-52
Zaria ..	17,109	15,517
Katsina ..	33,490	44,647
Sokoto ..	22,495	38,087
Bauchi ..	10,720	7,780
Adamawa ..	550	37
Bornu ..	260	—
Plateau ..	1,133	856
Niger ..	2,717	3,610
Kano ..	1,650	36
Benue and Kabba ..	5,321	2,857
Total ..	95,445	113,427

TABLE 6

Island	*Acreage*	*Production*
		400-lb. bales
Antigua ..	1,300	712
Barbados ..	206	45
Montserrat	1,970	850
Nevis ..	3,400	1,033
St. Kitts ..	220	118
Anguilla ..	60	10
St. Vincent	2,588	935
Total ..	9,744	3,703

West Indies

The area planted to Sea Island cotton in 1952-53 was 9,744 acres, compared with 14,755 acres in 1951-52; it was also much less than the average of the 10 years 1941-42 to 1950-51. Production was also less, resulting from the reduction in acreage following the uncertain outlook and the reduction in price, especially in islands where alternative crops can be grown. The total output was 3,703 bales, against 5,428 bales in the previous season.

Details of acreages and production in the undermentioned islands are shown in Table 6.

Photos: P. 62, Public Relations Department of the Government of Nigeria; p. 63, Sudan Government Agency in London.

Technical News

The February issue of *Paint Manufacture* includes 'Styrenated Drying Oils and Resins,' by P. Slansky; 'Thixotropy and Paints—2,' by R. Quarendon; and 'Economics of the Paint Industry—2,' by L. G. Wooder.

Fibres (Natural and Synthetic) for February contains 'Recent Developments in Copolymers—2,' by Leslie Valentine; 'Fibrous Minerals—2, Glass Fibres,' by A. E. Williams; 'Transforming Cotton into New Textile Products,' by C. H. Fisher; and 'The Effect of High Temperature Treatments on the Moisture Absorption of Viscose Rayon,' by A. J. Hall.

The contents of the February issue of *Dairy Engineering* include 'Should There be a Standard for Farm Milk Tanks?' by Stephen Michaels; 'Push-Button Cleaning of Farm Dairy Equipment'; and 'The Cheeses of Great Britain—8, Creamery Cheddar,' by K. D. Maddever.

Cotton in Morocco and the Tadla Research Station

C. H. BROWN, B.Sc.

Mr. C. H. Brown, whose name will be familiar to our readers, has recently spent much time in Morocco assessing the possibilities for cotton cultivation. In this article, he reviews the whole question and gives his opinion as to the prospects.

THE history of cotton growing in Morocco so far has been a chequered one. The soil and climate being judged similar to those of Egypt, serious attempts to grow the crop were started in the early 1920s and continued with varying success for the whole period between the wars. The crop was considered what is called locally a ' culture d'eclipse'; in other words, one in which periods of great general interest alternate with others in which its growth is almost entirely abandoned. The main influence in this instability are, of course, the alternation of shortages and gluts in world cotton supplies, with its consequent effect on prices.

In past years, many cotton varieties were introduced; they included both American Uplands for rain-growing cultivation and Egyptian for irrigated areas. The main district involved in these attempts was that of Sidi Shimane, inland of Rabat and Port Lyantey, in northern Morocco. It was one of the first areas of Morocco to benefit from modern agricultural development, and the first of the several main irrigation works came to fruition in this district. There also seemed, near the coast here, to be a better chance of suitable rainfall than in the drier south.

Early results

In the main, rain-grown Upland cotton was a failure, partly owing to the high incidence of insect enemies. The spiny boll-worm (*Earias*) was the main one concerned, to which the American varieties showed greater susceptibility than did the Egyptians. Of the latter, it was finally decided that Pima was a suitable choice and contemporary records state that it gave better yields than other varieties tried. From this period dates the selection of a local type, Pima 67, which has shown considerable success in adaptation to Moroccan conditions. It was taken as a standard and is now the only variety cultivated commercially.

Research provision

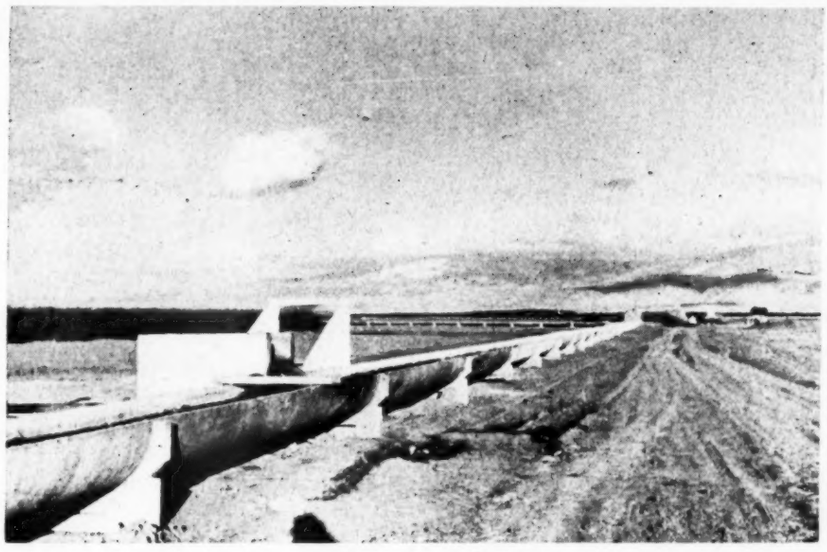
Those interested in the Moroccan cotton crop early appreciated that it would be necessary, for its success, to initiate the same kind of serious research which was already being developed in the principal growing countries, and in the early post-war years this was started at Rabat. The site chosen was the experimental gardens of the Centre des Recherches Agronomiques. About this time, however, it became generally realised that other areas in the country offered better promise for cotton, and interest began to centre particularly on the fertile Tadla plain in central Morocco. Here, the largest of the series of planned irrigation works was just coming to fruition, with an irrigable area of about 200,000 acres ripe for development. Accordingly, the decision was taken to move the research work from Rabat and restart it on a more ambitious scale in this plain.

The Tadla Research Station

So was born the Tadla research station. It was set up under the joint control of the two organisations in Paris, which had by then assumed responsibility for the general encouragement of textile crops in the French Union. These are the Compagnie Francaise pour le Development de Textiles and the Institut de Recherches du Coton et Textiles, the former being interested more in the general assistance of cotton growing and the latter in research. Thus it is that the station comprises areas devoted purely to

Primitive ploughing methods in Morocco

research and areas for seed propagation and the demonstration of improved cultural methods. The station began work in 1951. This was rather a boom period for Egyptian cotton, with prices kept up to exaggerated levels by the market manipulations of the Farouk government. The more normal price levels to which long-staple cottons subsequently fell were regarded with some disappointment by Moroccan growers, and the last two or three years have seen the crop again abandoned by many European farmers who had taken it up. It is, therefore, a time for taking stock of the position, more particularly in the light of the promise the work of the research station is able to offer for future development.



Irrigation canals on the Tadla Research Station

Prospects for cotton in Morocco

There seems little prospect at present of the Sidi Slimane region returning to the crop. It is a district of well-established citrus orchards and cotton growing does not at present offer sufficient economic attractions. The Tadla plain, with 200,000 irrigable acres, is therefore the most promising region of the moment, but the Doukkala plain, where production is just beginning, also offers promise. Here there are about 150,000 acres, near the coast, south of Casablanca, irrigable from a new dam. For the future, there is also much promise in the Triffa plain, a smaller irrigable area on the northern coast.

As things stand, the total area under cotton is only about 8,000 acres in the Tadla plain. This is almost exclusively under the control of the Office de Beni Amir-Beni Moussa. This is a central organisation of a semi-governmental nature for developing the area inhabited by these two tribes. Water has been provided in advance of the main irrigation scheme and with planned rotations and a central ginnery the district covered may be regarded as a pilot scheme for the whole Tadla plain.

Since it is the only area seriously growing cotton at present, it is by the achievement there that Moroccan cotton-growing must at present be judged.

The outlook and limitations

The Moroccan peasant has not yet acquired the skill of the Egyptian. The latter has developed, by a long process of trial and error, cultural methods which are adapted to give the best results. These have become such firmly established practice that little or no instruction from above is needed. In Morocco, on the contrary, there is ample evidence that the right sowing date, spacing and weeding would bring increased crops, but it is not easy to get these adopted in practice, although in time, as in Egypt, agricultural traditions suitable to the crop will no doubt be built up.

Present yields

The present average yield of about 350 lb. of lint per acre, against the Egyptian 500, in no sense, therefore, represents the full possibilities of this area. To estimate these we must first ascertain what the natural possibilities and limitations really are, and these can be best studied at the research station. Here, better cultivation immediately shows that crops comparable with those of Egypt can be relatively easily grown.

Climatic effects

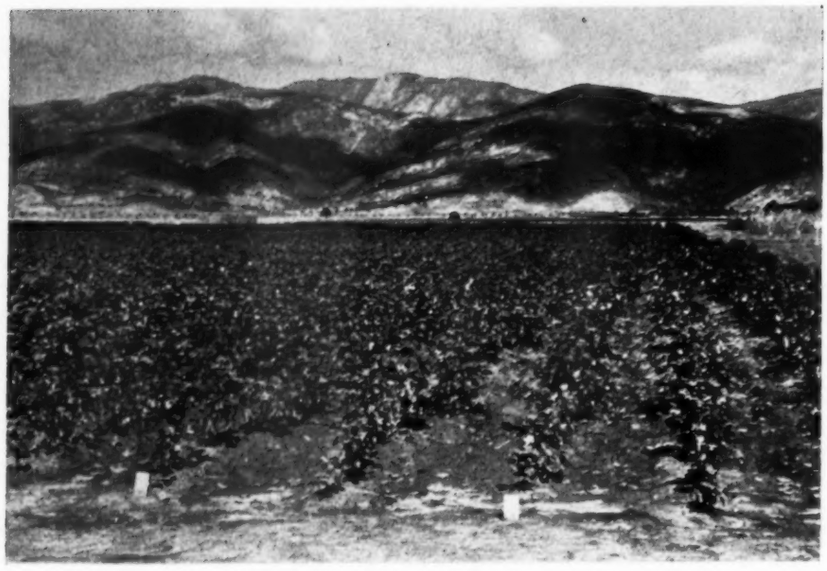
It seems clear that one of the main limitations of the Tadla zone is climatic. The extremely hot drying winds which often blow in July and August cause very heavy boll shedding and limit crop possibilities accordingly. The crucial importance of these ' chergui ' winds, as they are known locally, was very clearly demonstrated in 1954. In this year, days in which these winds blew and imposed an almost intolerable water strain on the plant were conspicuously absent, and the plants took full advantage of it. I saw in this season cotton plots which I think I can honestly say were better than any I have ever seen in Egypt; some extremely high yield figures registered in the experimental fields bore out this eye judgment.

It is clearly a matter of extreme interest to estimate how far the extension of irrigation, the consequent planting of trees, and the existence of the large lake area now held up by the dams in the nearby mountains, will effect a climatic change. A few degrees reduction in the summer maximum temperature with a lessening of the extreme atmospheric dryness, could clearly affect the plant's response in a startling manner.

Pests and diseases

One would normally expect diseases and pests to be a limiting factor, but as far as can be seen at present, and with all reservations for the future, this is not so. A little American cotton is grown for trial at the station and the difference between the two types in pest resistance is most marked. Pests as different as *Earias* and red spider seem to build up on American cotton, but losses on Egyptian types are so slight as to be almost negligible. The clean crop is pleasing and unfamiliar to one used to seeing the high proportion of damaged late bolls in Egypt.

There is one essential point of difference between the two countries. In



Cotton plots at the Tadla Research Station with the Atlas Mountains in the background

Morocco, from the beginning, it has been insisted that cotton sticks should be pulled up and burnt. In Egypt, the peasants' lack of any alternative source of fuel results in the keeping of cotton sticks over the winter being tolerated. I often thought that the crop loss from this practice was never sufficiently appreciated. Now I am sure of it. There seems a high probability that the freedom from boll-worm of the Moroccan cotton crop may be permanent. The pink boll-worm (*Platyedra*), although present, shows no signs of increasing as it did in Egypt, and another main Egyptian pest, the leaf-worm (*Prodenia*), is quite unknown.

Picking

Pima is one of the later maturing Egyptian types and it has been the practice in Morocco to let picking drag on into December, and even January. The research station has shown that with early sowing this is quite unnecessary and that a full crop can be obtained and plants uprooted by mid-November. Thus another Egyptian tradition, *viz.* that of planting a wheat crop, immediately following cotton, to ripen by the following June, becomes possible. It is already standard practice at the research station and will undoubtedly become so elsewhere in the future.

The Moroccan summer, although it can be hotter, is shorter than the Egyptian summer. Sowing has to be postponed to a later time in spring, *i.e.* to late March, as against early March in mid-Egypt. In addition, there can be early autumn rains, so that there is every interest in getting the crop picked as early as possible. There thus seems a high probability that Pima will eventually be replaced by an earlier maturing variety, but it is difficult, on present evidence, to judge which this is likely to be. A full breeding programme has been initiated, including both reselection of the available Egyptian varieties and new crosses, and the testing of the resulting material will take time. But many interesting possibilities are already emerging and that improvements can be made need not be doubted. An organised breeding programme can explore the full possibilities in a way which was impossible to the early selectors of the 1920s.

Grade

A high-grade crop seems to come naturally in Morocco in the absence of serious insect damage and there has emerged another special characteristic of Egyptian type cotton grown there. Climatic conditions seem to favour a particularly high fibre maturity and hair weights and maturity ratios are consistently higher than those found in the same varieties when grown in Egypt. As a result, a somewhat different staple is produced, giving a little lower yarn strength, but excellent yarn appearance. Such a cotton will always have a clientele, even if this has first to be discovered. The fibre produced at present is appreciated by French users and has been favourably judged by the few English spinners who have seen it. Whatever variety changes result from the present breeding programme, I should judge that a ready market will easily be found for the product.

Conclusion

What remains to be done now in Morocco, to establish the crop firmly in popular favour on a wide scale, is to prove convincingly the possibilities of a high average yield. From what I have seen there I am confident that this will come and in achieving this end the role of the new research station will be of crucial importance. Without it, cotton growing in Morocco would have languished, and might have died. The psychological effect of such a station continually redrawing attention to the possibilities could be even more important to Morocco than Giza has been to Egypt.

Fruit Preservation in Cyprus

With a view to demonstrating to growers the possibilities of preserving surplus fruits, demonstrations in fruit drying and bottling and jam making have been carried out in 14 main fruit-growing villages in Cyprus, according to the report of the Agricultural Officer (Horticulture) for 1953. The fruits dealt with included apricots, cherries, plums, apples and figs. These demonstrations, which created considerable interest among producers and other sections of the community, were attended by 3,200 adults and 261 school children. The founder of one of the largest preserving concerns in the United Kingdom, Mr. S. W. Smedley, visited the island in the spring and autumn. He has now decided to establish one and possibly two canning factories in the island and has bought for this purpose sites in the Limassol and Morphou areas.

Fish Culture in Conjunction with Rice Cultivation—2

W. H. SCHUSTER

Food and Agriculture Organisation

This is part 2 of Mr. Schuster's article on fish culture in rice fields. It discusses the practical aspects and the economics of the question.

IT would be difficult to write an essay on fish culture without discussing specifically the role of common carp as pond fish. The common carp (*Cyprinus carpio L.*), which has been reared in ponds in Europe since the Middle Ages and in China, Japan and Indonesia even longer, has proved to be the most suitable fish for culture in rice fields. Originating between the Black Sea and the Caspian Sea, the species has developed a great number of varieties which are often erroneously regarded as separate species. This mistake is understandable, since the fish reared at present show remarkable differences of colour and shape as a result of the selections which have been made to meet local preferences. The scaled carp of the Danube, the mirror and leather carp of Bavaria, Bohemia and Galicia, the goldfish from the Po Valley, the fish grown by the Israeli in brackish water ponds in the Negew desert and the fish which is a symbol of prosperity and fertility for the people of China and Japan are all varieties of common carp. And even the carp which is rejected as a coarse fish spoiling the waters of the U.S.A. and of South Africa is the same *Cyprinus carpio* which Anglo-Saxons have never learnt to appreciate as food and sport fish.

The Asian stock of *Cyprinus carpio* shows a typical disposition to albinism and flavinism. The offspring of a pair of breeders will in part consist of albinotic or bright-coloured specimens even when the parent fish are dark. In regions where people have no objection to eating typically coloured fish, selection has reached a degree where the natural dark green colour of the fish has almost disappeared.

The carp imported into Asia consisted partly of ' mirror carp,' a subvariety without any scales. According to current valid definitions, both of these are sub-varieties of the cultivated variety of common European carp, which is most typically represented by the ' Lausitz carp ' of Germany. What are known at present in East and South Asia as ' German carp,' ' mirror carp,' ' Prussian carp,' ' carpe miroir ' or ' edelkarper ' are merely the offspring of what was originally imported from Europe, mixed with scale carp of Asian origin. Even in Europe the genetics of the varieties and their cultural value are still being investigated and it is not surprising that there is no certainty whether European carp is superior in vigour or rate of growth. In Java, it has been established that imported German stock does not grow faster than selected indigenous stock. European carp gives a higher rate of production only if grown at an altitude exceeding 1,000 metres above sea level.

The food of carp

The common carp fits excellently into the biotope which comes into existence when a rice field is flooded with fertile irrigation water, but some facts about the feeding of carp should be mentioned here to clarify the relations between species and environment.

Carp is often described as omnivorous because of the varied nature of the food it takes. Thanks to the investigations of German scientists, we now clearly understand the nutrition pattern of pond-grown carp. Living organisms are the basic food, and this determines the supplementary feeding. Feeding of carp with potatoes, oil cakes and grain is often used in European and Middle East ponds and gives increased yields. Artificial food can be given to sustain a stock of fish at times when natural food is in short supply. Moreover, artificial feeding permits higher stocking rates.

Much less is known of the feeding and nutritional requirements of common carp in tropical regions. Observations by the author show that young carp in rice fields feed on planktonic and epiphytic organisms. When the fish reach a body length of 3 cm. a distinct change of habit takes place, and from then on a large portion of the food consists of insect larvae. The gut contents of carp from rice fields often consist chiefly of the red and yellow larvae of *Chironomus*, *Endochironomus* and related genera.

Carp seem to prefer the larvae of gnats above all other feeds. Whoever has seen the waterlogged soil of a rice field perforated by millions of tiny holes and has seen the mud alive with larvae will realise the effect which these must have on the environment. The importance of the larvae as food for carp can hardly be over-estimated, and they are of some importance to agriculture too. The burrowing larvae loosen the soil and carbon-dioxide-consuming and oxygen - producing algae are able to grow in the holes made by the larvae. Still more important is the role of the larvae in the decomposition of organic matter. They feed on this and are chiefly responsible for the quick disintegration of the rice straw which remains on the field after the harvest of the paddy. The larvae are also significant because a great amount of nitrogen is temporarily retained in the protein of their bodies.

If the larvae developed into mature insects, this nitrogen would be completely lost from the nutrient cycle of the fields. The carp feed on the larvae and convert the insect protein, which otherwise is not available to man, into fish meat and return to the field droppings, which act as fertilising material. Similarly, the puddling of the mud by the fish in search of food has a stimu-

A typical tambak or brackish water fish pond

lating effect on the crop. The rapid mineralisation of vegetable matter and aeration of the soil thus brought about seem to give rice fields a better than normal plant nutrient reserve available to the next crop.

Although animal and vegetable plankton are important in the breeding of common carp, carp is actually a bottom feeder and the fauna and flora on the bottom of the pond is of much greater importance than the floating organisms. In Europe, where ponds are rich in plankton during the summer, earlier observers over-estimated its importance and observations by the author in tropical regions point to the same conclusion. The productive rice fields of Java are poor in zooplankton, especially *Phyllopoda* and *Copepoda*.

Rearing carp in rice fields

A field on which rice is grown must be flooded for four to five months; in the northern and southern border regions of rice cultivation and in tropical upland areas the flooding period might even be six months or longer. Since about 30 days elapse before the field is tilled and the transplanted rice seedlings have become established, three to four months are available for fish culture. Rice can be cropped twice a year where water is available and the soil is sufficiently fertile, and under these conditions almost continuous fish cultivation is possible. Poor soil fertility requires that the field should lie fallow for some time after each crop of paddy, or that crops such as legumes, maize and peanuts should be grown in rotation with paddy. If it is possible to supply water for at least three months, fish can be grown on such land as the ' secondary crop.' In some areas where the supply of water is plentiful enough to permit irrigation throughout the year, although fertility is only moderate, continuous utilisation of the fields is possible in a system of three harvests of paddy in a two-year cycle. In such areas, the fields are flooded for fish culture in the fallow period between rice crops.

When a field is to be used for fish cultivation the dikes (bunds) are reinforced at the time that the field is prepared for the planting of rice. Depending on the size of the field, marginal or cross trenches, 50 cm. wide and 30 cm. deep, are dug to serve as a shelter for the fish in the event of an interruption in the supply of irrigation water. The inlets and outlets are fitted with screens and five to ten days after the paddy has been planted the field is stocked with fish. No further care of the fish is needed until the harvest, except that the dikes must be watched and the water level checked, which, however, is necessary even if no fish are grown.

It is obvious that successful fish cultivation requires a regular and plentiful supply of young fish. Where are young fish obtained in quantity sufficient to stock hundreds of hectares of rice fields? In countries where fish culture is a new enterprise this might indeed be a serious problem, but there are many areas where rearing and propagation of freshwater fish is a highly developed local industry. Artificial reproduction of common carp in hatcheries is not confined to Europe; in East Asia fish farmers prepare spawning ponds with the same care as do their Western colleagues and equally carefully transplant fertilised eggs to fry ponds, collect young fish later and ship them over great distances. Where fish culture is in the initial stage, the supply of stocking material from governmental breeding stations is a *sine qua non*.

Variations in yields are due to the inevitable losses of fish, which make full exploitation of the production potential impossible. Losses through predation and escape may sometimes be as high as 80%. Since stocking material is inexpensive and readily available, satisfactory yields can be ensured by initial over-stocking. The normal stocking rate is 15 to 20 fish of 5-cm. length per 100 square metres, but this might be increased to 30 and more if conditions are less favourable.

In sub-tropical climates, rearing of stocking material from spawn or fry and rearing of marketable stock in a one-year cycle are carried out. The rearing period is about six months. Where big fish are in demand, one-year-old stock can be wintered in special storage ponds and in the following year returned to the rice fields for a second growing period.

Tilapia

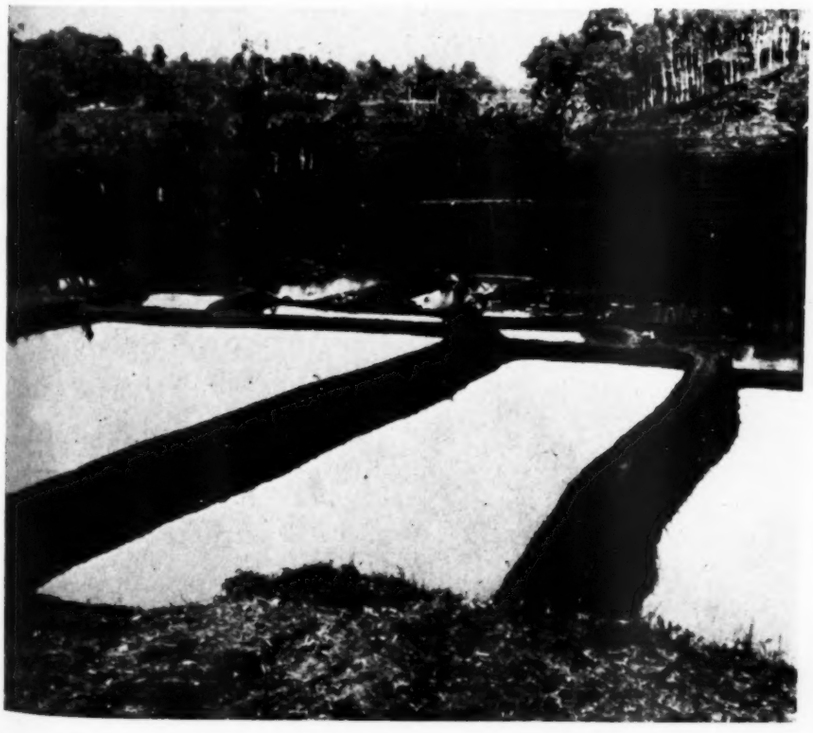
The culture of *Tilapia*, the fish second in importance for stocking of rice fields, is a comparatively new feature in inland fisheries. Prior to 1939 hardly anyone except professional ichthyologists was familiar with this group of African fishes. In that year, a few specimens of *Tilapia mossambica Peters* were found in Java and initial cultivation was undertaken under guidance of the author. From those few specimens has developed the enormous stock of fish which has made *Tilapia* the most important pond fish in East

Asia. In the Belgian Congo, the initiative was taken in 1946 to investigate the suitability of indigenous *Cichlids* for cultural purposes. The effort resulted in the selection of several *Tilapia* species and in the development of the rather important Central African area of *Tilapia* cultivation.

Tilapia mossambica, now well known to fish culturists in Ceylon, Indonesia, Indo-China, Malaya, the Philippines, Thailand and Taiwan, can be grown in fresh and brackish water, in ponds and fields, in the plains and in the mountains, in lakes and in reservoirs. It is a hardy fish which reproduces everywhere without special care. A striking example of its potentialities is the ease with which it has been introduced to the Caribbean area: in two years it has gained a significant place as a pond fish.

As in the case of carp, the feeding habits of *Tilapia* have a beneficial effect on the growth of rice. Whatever cultivation practices are followed in a rice field, it is impossible to prevent the occurrence of submerged water plants. Often dense layers of algae cover the soil and prevent light penetration and absorb great amounts of nitrogen, potassium and phosphorus. It is impossible to remove them mechanically, but biological control is possible, for algae are the preferred food of *Tilapia*, and a fish stock of normal density is able to clear a field of algae in a few weeks. A proportion of the nutrients will be returned to the cycle within 24 hours after stocking by excretion by the fish and the rapid destruction of wastes by bacterial and enzymic action.

The technique of *Tilapia* culture in rice fields is almost identical with that of carp culture. Shallow ditches are dug in every field to provide shelter for the fish; they also serve as spawning places, since *Tilapia*, in contrast to carp, reproduces in the fields. The stocking rate is 10 to 100 fish of 1 to 3 cm. length per 100 square metres, with, in addition, some big fish to serve as spawners. Yields often exceed 1,000 kg. per ha. per annum. Outside the zone from 25°N to 25°S the climatic conditions differ from those in the region of origin of *Tilapia*. Since *Tilapia* requires water at 15°C. or more, and since in this extra-limital area the water has this temperature for only a relatively short time, the growth of natural fish food should be stimulated by fertilisation with compost or other kinds of organic matter. Also supplementary feeding with rice bran or soya bean meal might be applied.



Fields in Indonesia ready to be planted with rice and fish

In Taiwan, in 1952, this system yielded an average production of 275 kg. of fish per ha. with an average paddy production of 5,699 kg. per ha. Fields which had hitherto not been stocked with fish produced a crop of paddy which was 209 kg. per ha. higher than that of stocked fields. The lower rates of production are attributed to the loss of paddy production from the areas occupied by ditches which, because of climatic conditions, had to be made especially broad. However, since the price of fish was about twice that of paddy, fish culture was profitable to the farmers in 1952.

The effects of fish culture on rice culture

So many advantages of fish culture have been stated that the critical reader might wonder why the system is not more generally applied. Actually, it has no particular disadvantages, and the reasons for limited application are to be found exclusively in lack of knowledge of the methods.

The most valid objection to fish culture is the greater use of irrigation water. Where an additional supply of irrigation water for fish culture is not possible, no attempt should be made to stock fields.

In the initial stage, there might be doubt about the suitability of the practice for all types of rice. Some paddy varieties grow best in shallow water and, since a minimum depth of 10 cm. is required for fish, fields planted with shallow-water types of rice should never be stocked. If fields were flooded beyond the conventional depth also, the diminished heat absorption of the soil might be followed by adverse effects. On the other hand, there are many types of rice for which 10 cm. deep water and more is essential for good growth, not to speak of the 'floating rice' of the monsoon areas, which can grow in water exceeding 1 metre in depth. It should not be difficult for agriculturists to indicate for each area types of rice with which fish can be grown.

Occasionally anxiety is expressed that fish might damage young rice plants. It can, in fact, happen that in their search for food carp uproot seedlings which are not yet firmly established. However, if stocking is delayed for five to 10 days following planting,

there is little risk of rice plants being uprooted and, on the whole, the injury caused is negligible.

In some areas, the rice is frequently affected by a virus disease which causes the stems to rot. The best method to control the disease is to drain the field and let the soil dry for some days. Since this procedure would not be possible if the fields were stocked (unless, of course, protective ditches are available), fish culture should not be undertaken in areas where this virus disease is known to occur. It has not been proved that continuous flooding affects the frequency of virus infections, but it is not advisable to take risks; such areas should therefore be avoided.

Cultivation of fish, on the other hand, has a distinct value as a means of controlling damage by insects; for instance, by stem borers. It is, moreover, often the only practical means to check the occurrence of malaria-carrying *Anopheles*, which often breed in rice fields. Great advances have been made in the control of malaria by stocking fields with common carp.

Discussion

Careful consideration of what has been said above will confirm that the agronomist has here a means of considerably improving land usage. To answer the question whether there are actual examples of successful fish culture in areas where it has been introduced, one could point to Malaya, where fish was first released in 1921 and where production has increased to such a degree that exportation on a considerable scale is possible. Further, one could point to Indonesia, where hundreds of thousands of people eat *Tilapia* daily. One could also point to Thailand, where, as a result of technical assistance, thousands of ponds have been constructed within two years and where a beginning has been made with fish culture in rice fields. One could, moreover, mention Haiti, where FAO experts have stocked carp and *Tilapia* in wet rice fields covering thousands of hectares and where the fish have established themselves more or less within a year. There are many more examples of successful introduction and it is possible to sketch the lines along which new operations should be planned.

The key consideration should be to establish what type of fish would most satisfactorily meet the local demand. There are areas where people refuse to accept other than big fish for food, and it would entail intensive propaganda over a number of years to convince them that small fish can provide an equally delicious dish. Meantime, fish culture in rice fields could hardly make much headway and in such areas pond operation could be tried. There are, however, vast regions in which consumption of small fish is conventional, and here the fields are ready for stocking. Vocational training of adult farmers has shown the most promising results and if the introduction of fish culture is to be successful results will have to be achieved by demonstrations and on-the-spot training of local workers. In countries where there is an established agricultural extension service there will be no difficulty in organising demonstrations. The next step would be continued research.

The systems described have established the principles; we have practical experience in certain regions and we have experimental proof that the systems have good aspects in others. But we still lack the all-round knowledge necessary for an application under all conditions, and this can only be supplied by research.

Photos: FAO

English Coastal Flooding Payments

Proposed rates of acreage payments for 1955 on land that was damaged by the East Coast floods of January 1953 and has not yet been fully restored have been announced. The Minister of Agriculture and Fisheries proposes to lay before Parliament a draft of the third scheme under the Coastal Flooding (Emergency Provisions) Act, 1953. This will enable acreage payments to be made during 1955 for the purpose of rehabilitation of arable and pasture land that remains damaged by salt water. Acreage payments will be conditional on the land being dealt with in a manner approved beforehand by the County Agricultural Executive Committee. They will be paid, as the Act requires, to the person who occupies the land on June 4, 1955. (Where there is a change of occupier during the year, these payments can be taken into account in the outgoing valuation.)

Subject to Parliamentary approval of the scheme, rates of acreage payment will be as follows:

	£ *per acre*
Land which is pasture on January 1, 1955, and which is retained as pasture ..	6
Land which is used for the growing of crops or for the laying down of pasture ..	10
Land which is bare on January 1, 1955, and which is retained uncropped	10

Contributions towards rehabilitating allotment gardens will be paid where appropriate to an association, local authority, or society, at the rate of £16 per acre for not less than half an acre of land. Gypsum will again be delivered free to farms where County Agricultural Executive Committees recommend its use for the rehabilitation of salt-damaged land.

New Year Honours

In the British New Year Honours List appear the names of the following for service connected with agriculture to whom WORLD CROPS tenders its congratulations:

Knights Batchelor

Arthur Cyril Richmond, Chairman of the Land Settlement Association and of the Federation of Agricultural Co-operatives in Great Britain and Ireland.

Eldred Frederick Hitchcock, for public services in Tanganyika.

C.M.G.

J. I. C. May, Director Empire Cotton Growing Association.

B. A. Cash-Reed, Attaché for Food and Agriculture at H.M. Embassy, Washington.

T. Yirrell Watson, Secretary for Agriculture and Natural Resources, Uganda.

C.B.E.

C. E. J. Biggs, Director of Agriculture, Tanganyika.

G. W. Lines, Director of Agriculture, Sierra Leone.

J. Wright, Director of Agriculture, Jamaica.

Kapok

A. E. HAARER, F.L.S.

The following article is based on an unpublished manuscript written by the late Dr. P. J. S. Cramer, which his widow, through the kindness of Ir. G. G. Bolhuis, of the Landbouwhogeschool, Wageningen, Holland, supplied to Mr. A. E. Haarer with permission to make use of it as he thought fit.

THE flosses, or the so-called silk-cottons, are produced by many wild growths in tropical regions, especially among the families *Bombacaceae*, *Apocynaceae* and *Asclepiadaceae*.

As examples we have *Ceiba pentandra* Gaertn., formerly known as *Eriodendron aufractuosum*, which produces the kapok of commerce; *Bombax malabaricum*, which produces an inferior kapok; several other species of *Bombax* and the baobab tree, *Adansonia digitata*. These all belong to the family *Bombacaceae;* the rubber-producing tree, *Funtumia elastica*, the arrow poisons, *Strophanthus* spp. and *Acokanthera* spp., are in the *Apocynaceae* family; while *Calotropis gigantea*, together with *Asclepias* spp., produce similar pod fibres among the *Asclepiadaceae*. Many more could be mentioned, but, except for the first two, the others are inferior to kapok or cannot be cultivated economically because of their nature, their low yields or their peculiar environmental requirements.

In East Africa, kapok is not looked upon with favour because the tree is a host of the cotton stainer bug, *Dysdercus*, while in West Africa both *Bombax* and *Ceiba* species have proved to be alternative hosts for the virus causing swollen shoot disease of cocoa, and also for the mealy bug vectors which transmit the virus.

Characteristics of kapok

The kapok tree, *Ceiba pentandra*, is a very striking tree; the bark of the younger growth is a vivid green and the branches grow out in successive whorls at right angles to the main stem. It is native to both Africa and Asia within the equatorial belt; in West Africa it grows to a great height in the jungle; it can be readily grown from seed or from pole cuttings. Often the seeds are sown at stake. If they are sown in a nursery, the young plants are planted about 15 in. apart and lightly shaded until a few months before they are planted out in the field. They should then be not much more than 18 in. tall; it is the usual practice to cut off most of the leaves before the plants are moved to prevent the transpiration of moisture and the wilting which this would cause.

Kapok in Indonesia

About 90% of the kapok is grown by native growers in Indonesia and the plant is rarely raised to the status of a plantation crop. It is grown by a few planters as avenues along roads in plantations of coffee or cocoa, or among the other shade trees used for these crops. It is not a good shade tree because it is deciduous and the leaves fall when the dry and hot seasons begin.

It is useful, however, as a stiffener among *Albizzia* or *Erythrina* shade where winds may be strong and cause breakages among the planted shade trees.

When planted as avenue trees they are usually spaced about 15 ft. apart, but in square planting they should be planted 20 to 25 ft. apart. The kapok produced by the natives is obtained from clumps of trees in villages and compounds, from scattered plantings and from trees planted in hedges, in gardens near houses and along roadsides.

The tree grows to about 30 ft. in height in three years and in the fourth year bears its first economic crop. The palmate leaves drop at the beginning of the dry season and the greenish-white flowers are produced on the bare branches, followed by the green pear-shaped pods which turn brown and ultimately split in half, scattering the seeds and floss far and wide. The pods are ripe, however, long before they split open, and when they are beginning to split the trees are climbed and the fruits are gathered with the aid of long bamboo rods fitted with hooks. The pods hang drooping from the

Kapok trees along the boundaries of a terraced holding in Java

branches, so they are easily detached and gathered up from the ground. A pod is from 2 to 2½ in. in length and the seeds are borne in a layer on the placenta or central core, while the fibre grows from the inner side of the husk and is folded in small packets against each seed in the pod.

Treatment of the crop

The pods are carried to barbecues enclosed in cages of wire netting, wherein they are opened and the seeds and fibre separated from the outer husks and cores. It is necessary for the barbecues to be placed in sunny and exposed situations and the cages are required to prevent the floss being blown away, because a gentle breeze is sufficient to scatter it. The fibre loosens itself when the pods are ripe, and the smooth seeds tend to drop through the fibre on to the floors of the barbecues as the fluffy floss is lifted and shaken by bamboo forks. While this is taking place the floss is sunned and dried so that it may ultimately be heaped in readiness for baling.

Improvised machinery is used on some estates in Indonesia. This usually consists of a horizontal cylinder having a central axle on which fixed paddles move between fixed bars, beating the seeds out of the mass. The lower part of the cylinder is composed of mesh wire, through which the seeds fall, and a fan sucks the free fibre to one end of the cylinder, where it is collected.

The ease with which the tree is grown, its freedom from serious pests and diseases and the simplicity of the technique of production makes kapok a very suitable crop for the native peasant farmer. Most of the kapok produced in Indonesia comes from Central Java and East Java. Japara-Rembang, Semarang and Malang are the important centres of native kapok production and the outer provinces of Celebes and Atchin produce about 10% of the total.

According to Dr. Cramer, kapok was a most important fibre crop in Indonesia in 1946, if one considered the total value of the exports, including by-products, such as the seeds, the oil and the press cake. By value in 1939, kapok was listed twelfth in importance of all the products exported from Indonesia and accounted for 72% of the world's total exports of kapok fibre.

Gathering kapok pods

Prices for kapok

The market price has been as low as 5d. and less per lb. At the moment of writing the price stands at 3s. 6d. per lb. for Javan kapok, 2s. 11d. for Ceylon, 2s. 10d. for East African machine cleaned and 2s. 8d. for Calcutta floss.

Indian kapok

Much of the Indian kapok is obtained from *Bombax malabaricum*, a large, upright, quick-growing deciduous tree with large and less regular spreading branches. The tree is very beautiful when covered with its large, fleshy, bright red flowers borne when the tree is leafless. The flowers are eaten in India and as they drop they form a scarlet carpet upon the ground.

It is not easy to climb and harvest the fruit from *Bombax* trees, since the trunk and branches are very prickly; moreover, the fibre is not true kapok and is inferior in quality, hence the lower price for the Indian floss.

Both trees grow easily and well in somewhat sandy or loamy soils in dry and hot coastal regions up to 2,000 ft. altitude, where the rainfall averages about 30 in. per annum and falls in a definite season followed by dry weather. Since the trees are deciduous they can withstand periods of drought and thus be grown in regions where the rainfall is erratic. In fact, the crops are never so good when a season is abnormally wet.

When once established the trees will withstand weeds and neglect and put up with a poorish soil. For many reasons the crop is a useful one for peasant farmers in difficult semi-arid areas where other crops are grown at hazard. The trees need no particular attention and their crops may be harvested or neglected, as the case may be,

EXPORT OF KAPOK PRODUCTION FROM INDONESIA
(in metric tons)

Year	*Export of native kapok*			*Total exports*
	Java	*Outer provinces*	*Total*	
Fibre:				
1935	21,385	1,975	23,360	25,653
1936	23,222	2,656	25,878	28,439
1937	14,148	2,383	16,531	19,018
1938	11,575	2,220	13,795	16,344
1939	18,312	1,341	19,653	21,786
Seeds:				
1935	11,094	1,799	12,893	17,199
1936	14,420	2,423	16,843	21,702
1937	11,786	2,976	14,762	19,465
1938	2,509	1,934	4,443	9,033
1939	4,831	2,400	7,231	11,144
Seed oil:				
1935	4,373	—	4,373	4,373
1936	2,981	—	2,981	2,981
1937	3,239	—	3,239	3,239
1938	1,696	—	1,696	1,696
1939	6,539	—	6,539	6,539
Press cake:				
1935	12,060	—	12,060	12,060
1936	23,529	—	23,529	23,529
1937	17,887	—	17,887	17,887
1938	13,254	—	13,254	13,254
1939	21,170	—	21,170	21,170

N.B.—The above table is extracted from Dr. Cramer's MS.

in accordance with the fluctuation in market prices. The central wood of the thick trunk is soft and light, hence logs may be hollowed out for dug-out canoes. The timber is said to be useful for making matches, boxes and for many domestic purposes in areas where other useful trees do not grow easily.

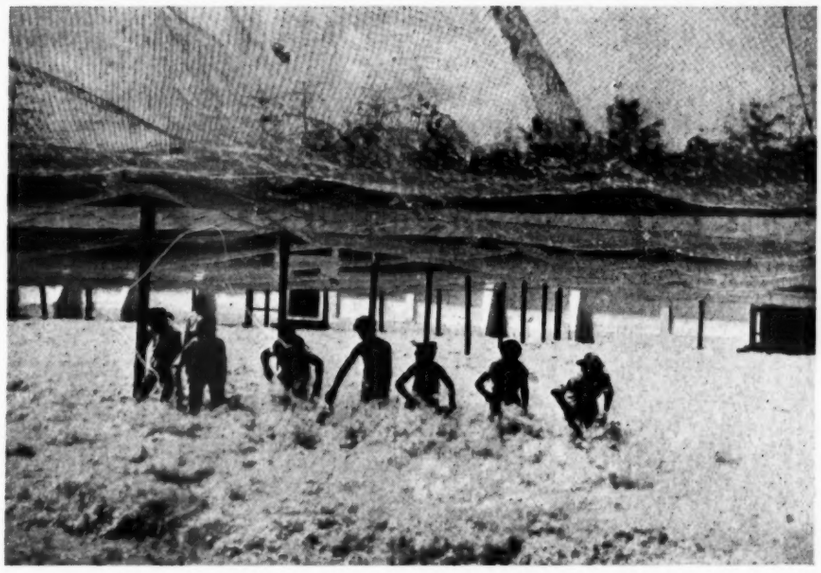
Uses for kapok

It is well known that these silky floss fibres are too smooth and slippery for ordinary spinning. Moreover, as fibres go, they are very weak. Many efforts have been made to crinkle or roughen the fibres so that they may hold together when spun into yarn and, though there has been success in recent years in mixing floss with other fibres for textile purposes, it cannot be used alone unless it has been treated by a chemical process.

The floss is mostly used for stuffing pillows and cushions; also for life-belts and life-jackets. Each fibre is a thin bladder-like tube filled with air and, since it is impervious to water, its buoyancy is ideal for the purpose of making life-belts to float in water. When the floss is used for this purpose the separate fibres must not be damaged so that their air-tightness is destroyed. They must not be roughly handled during the cleaning operations or pressed too tightly. Much of the native produce in Indonesia is bought by Chinese merchants, who have drying floors, storage rooms and presses. At the place of export—for instance, at Semarang—there are mills where the produce is worked over and pressed rather more tightly. Rigorous measures are taken against risk of fire, as kapok is exceedingly inflammable.

Kapok seed

Apart from the fibre, the seeds are of value. About 15,000 pods give 3 picul or nearly 410 lb. of seed-kapok, of which one-third is fibre and two-thirds seed. Other authorities give 1 lb. of floss from 80 to 100 pods and say that the first year's yield is from 1½ to 2 lb. of kapok per tree. The trees vary in yield and are sometimes biennial, so that a tree may bear heavily one year and be barren the next. A good 15-year-old tree may produce about 800 pods and thus about 8 lb. of clean floss. A single pod has from 100 to 150 seeds, and 200 fresh seeds weigh about 1 oz. By weight the dried pods contain about 50% seeds, 35% floss and 15% core.



Separating and sunning the floss under a cage of wire netting

A part of the seed crop of Indonesia is exported as such, while a local industry expresses the oil out of the remainder. A proportion of the oil and press cake is also exported, though the press cake is used as a manure and finds a ready market in Java. The shells of the pods have been found to be rich in potash, so they are burned and the ashes used on the land.

Kapok seed resembles cotton seed in that the oil contains about 20% palmitic acid glyceride among the mixed fatty acid esters, though it contains more oleic acid, *i.e.* about 50%, as against 30% for cotton seed, and less linoleic acid, *i.e.* about 30% against 50%, and about the same amount of stearic acid calculated as weight per cent. The seeds from *Bombax malabaricum* differ in that they appear to contain more oleic and less linoleic acid.

Kapok is chiefly exported from Indonesia, India, the Philippines, Ceylon and Tanganyika, and no sooner does the price rise to round about 1s. per lb. or more than greater interest is taken in the crop. Even so, in Tanganyika it grows successfully in regions where sisal is a better economic proposition. Provided its presence does not increase the stainer bug population in regions where cotton is grown, kapok planting should be very helpful as an adjunct to peasant farming. In the years when droughts affect food crops kapok may give returns in cash which would help villagers to buy food. Since the trees require a minimum of attention in their mature years, there is little call upon the labouring hours of a peasant's household to compete with the needs of his food crops.

The tree grows in regions where the cashew nut thrives, so that a mixed planting would spread the risks. In Asiatic countries the trees are some-

Continued on page 78.

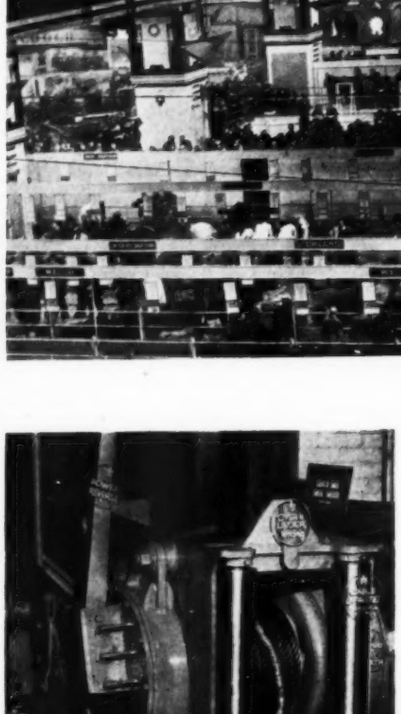
An avenue of kapok trees in a coffee and cocoa plantation in Java

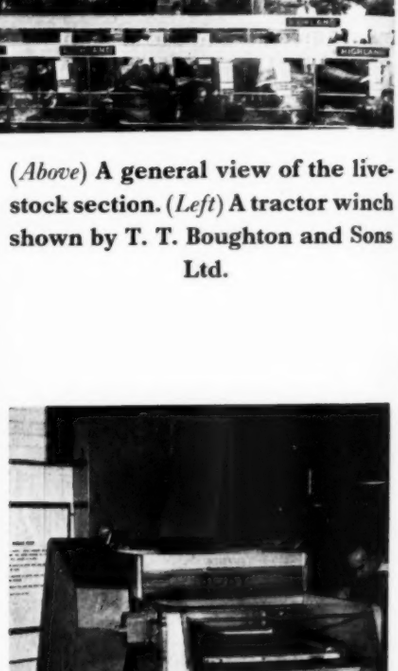
THE SMITHFIELD SHOW

A report of the Smithfield Show, which was held at Earl's Court, London, in December, appeared in our last issue. We reproduce on this page some photographs taken at the Show by our staff photographer

(*Above*) **The new tricycle conversion of the Fordson Major for export territories**

(*Above*) **A general view of the livestock section.** (*Left*) **A tractor winch shown by T. T. Boughton and Sons Ltd.**





(*Above*) **The Boby 'Unidresser' exhibited by Jack Olding and Co. Ltd.** (*Left*) **The Kenneth Hudson 'Timmis' potato shaker digger**

Citrus Cultivation in South Africa

C. J. NAUDE

Citrus and Subtropical Horticultural Research Station, Nelspruit, South Africa

THE principal factors to be considered in the cultivation of citrus fruit are situation, soil and climate. These factors must receive careful consideration when selecting a site for a citrus orchard, and one of the most fatal mistakes is to attempt to cultivate citrus in localities which are not suitable in every respect. Citrus, like any other plant, has its specific requirements, and optimum results will be obtained only under certain climatic conditions and on certain types of soil. The importance of being absolutely certain, before planting, that citrus will thrive in a particular area cannot be sufficiently stressed.

Certain important and well-known facts about citrus to be considered in the choice of a site are here briefly discussed to serve as a guide to those who wish to decide on the suitability of a particular spot for citrus and the species or variety likely to thrive best.

Climate

Minimum temperatures. Although citrus trees can resist light frost without any serious results, there is danger that, in places where severe cold may be experienced, the trees may at some stage of their life be severely damaged or killed by frost. It is therefore safest to accept as a general principle that only frost-free areas and areas not likely to experience abnormal cold will be suitable for the cultivation of citrus.

The different citrus species vary in their resistance to cold, and the extent of damage by cold will depend, firstly, upon the minimum temperature and, secondly, the duration of such low temperatures. Naturally, the lower the temperatures and the longer their duration the greater the damage will be.

According to observations in America, exposure of orange trees to temperatures varying from —3.9° to —3.3°C. (25° to 26°F.) for an hour or more will injure the leaves and young shoots; at —9.4° to —7.8°C. (15° to 18°F.) sections of large branches will be killed by frost and if temperatures of —11.1° to —9.4°C. (12° to 15°F.) prevail sufficiently long, frost will kill whole trees. Of the commercial citrus species, citrons and limes are the most sensitive and their leaves and twigs are known to have been damaged at temperatures as relatively high as —1.1° to —0.6°C. (30° to 31°F.). Lemons are more sensitive than orange trees, and will therefore suffer considerably more at the temperatures given above. Grapefruit, on the other hand, are slightly less sensitive than lemons, but not quite as resistant as orange varieties. The leaves and twigs of Bitter Seville and naartjie types are hardier than those of oranges, but may also be killed at temperatures varying from —9.4° to —6.7°C. (15° to 20°F.) if exposed sufficiently long.

The blossoms and young fruits of all citrus species are more or less equally sensitive to cold, and exposure for short intervals to temperatures varying from —1.1° to —0.6°C. (30° to 31°F.) is sufficient to kill them. The ripe fruit is about as sensitive as the leaves and its freezing point is at approximately —2.8° to —2.2°C. (27° to 28°F.). Frozen fruit is damaged in various ways and, because it dries rapidly, is unsuitable for marketing. Severe cold during flowering or just before picking may cause serious losses. Hence, in selecting a site, the first consideration is whether or not the particular site is too cold for citrus.

Maximum temperatures. Citrus species thrive well in areas of relatively high mean temperature, but a sudden rise to abnormally high temperatures may scald the leaves, cause the young fruit to fall and adversely affect the quality of the fruit. Such damage usually is aggravated by hot, dry winds, especially if these follow on a spell of cool weather.

Valencias, lemons and grapefruit are far less affected by such conditions than, for example, Washington navels, and thus the former are to be preferred where cold conditions are likely to occur.

Mean temperatures. Between the maximum and minimum temperatures within which citrus may be successfully cultivated the mean temperature is the principal factor in determining the species likely to thrive first and the approximate time of ripening of the fruit.

A variety like the Washington navel usually yields larger crops and the quality of the fruit is also better where the mean temperatures are not very high and the difference between winter and summer temperatures is fairly great. Experience shows that relatively cold winters have a beneficial effect on this variety unless, of course, the temperatures drop so low as to damage the trees. Areas like the Sunday River and the Kat River Valleys, which, for example, comply well with these requirements, are, therefore, more suitable for navels than the sub-tropical areas of the Eastern Transvaal Lowveld. This is, however, a fairly broad statement and certainly does not suggest that navels cannot be successfully grown in many areas of the latter region. What, however, it is desired to stress is that in warmer areas, which obviously do not comply with the above-mentioned requirements, it is better to plant Valencias, mid-season orange varieties, lemons and grapefruit in preference to navels. These varieties are not affected by warm conditions to the same extent as navels and grapefruit especially require much total heat to ripen properly and develop good quality. Generally speaking, mid-season orange varieties require more heat than Valencias and also less cold in winter than navels.

Height above sea level. The height above sea level is important only in so far as it affects the climate, and citrus can be cultivated as successfully near the coast as in areas 4,000 to 6,000 ft. above sea level, if the climate is suitable.

Winds. Strong winds adversely affect citrus, because they damage the fruit. In unsheltered areas which experience much wind, the fruit is always badly damaged and a large percentage is rendered unsuitable for export.

Strong winds may break the branches, and arid, hot winds may

cause very serious damage by drying the leaves and fruit to such an extent that they drop. It should, therefore, be borne in mind that, when cultivating citrus in such areas, provision will have to be made for effective windbreaks.

Rainfall and relative humidity. Citrus trees require more water at certain times of the year than at others. There are few areas where the rainfall is adequate and sufficiently well distributed to make irrigation unnecessary. As a rule citrus requires most water from July or August (just before blossoming time) to March, after which less is required. If, therefore, the regular effective precipitation is not at least 76.2 to 101.6 mm. (3 to 4 in.) per month during the abovementioned critical periods and at least 25.4 to 50.8 mm. (1 to 2 in.) per month for the remaining portion of the year, it must be considered insufficient. Unless there are possibilities of adequate irrigation, such an area will be unsuitable for citrus cultivation.

If sufficient irrigation water is available, the rainfall, as such, does not greatly affect citrus one way or the other, and they may be cultivated in areas where the annual rainfall varies from 127 mm. (5 in.) and less to 1,524 mm. (60 in.) and more.

A high relative humidity and a high rainfall may, however, in certain respects affect the variety grown. Owing to various diseases which attack the trees and fruit, lemons, for example, cannot be grown in Florida, where the humidity is high and the rainfall exceeds 1,524 mm. (60 in.). In South Africa, black spot in lemons is normally more severe under conditions of great humidity. The relative humidity and the rainfall may, because of their indirect effect on the promotion or suppression of certain diseases and pests, determine what variety will thrive best in a particular area. Before deciding on a particular variety it should first be definitely established that the regional conditions are not such as to rule out the choice of that variety.

Soil

The physical are for the greater part of more importance than the chemical properties of the soil. A prominent characteristic of citrus trees is that their roots require much oxygen, and to ensure that there will never be a deficiency of it it is most important, first, that the soil be well drained and, secondly, that it be not too heavy.

Drainage. When soils are wetted, water displaces the air and thus for long periods the available oxygen in poorly-drained soil will be insufficient. Under such conditions the roots lose vigour to such an extent that they easily succumb to fungi. Citrus should never be planted in poorly-drained soils accordingly.

Texture. The aeration of very heavy clay soils is unsatisfactory, and for this reason the objections to such soils are virtually the same as those to poorly-drained soils. Heavy clay soils usually have a high water-holding capacity and consequently remain wet for long periods, so that the aeration is insufficient. This condition is particularly serious in areas with a high rainfall. Generally, citrus does not do well on such soils, the trees grow more slowly, tend to be dwarfed and usually many die because the roots are readily attacked by disease. The cultivation of clay soils is very difficult and, in addition, the question of how irrigation is to be applied is a problem in itself. It is advisable, therefore, that citrus should not be planted on such soils.

Light, sandy to medium loam soils are more suitable for citrus. The presence of loose, small and large stones certainly renders cultivation more difficult, but as long as the stones do not form an impermeable layer likely to hamper drainage no objection exists.

Depth of soil. Most of the roots of citrus trees are concentrated at a depth of 2 to 3 ft., but may penetrate to 4 ft. and deeper. Good soil to a depth of 5 ft. is better than good soil only 4 ft. deep, but the latter is still satisfactory and, under certain conditions, citrus may be grown reasonably successfully on soils which are suitable to a depth of only 3 ft. The depth to which good soil is effective is limited by factors which hamper good drainage, as, for example, heavy layers of clay, solid rock strata, impermeable formations or a shallow water table. To correctly determine the suitability or otherwise of a particular area for citrus it is necessary to dig a number of holes all over the area and to examine the subsoil generally.

Chemical properties. A fertile soil with good physical properties is naturally better than one with more or less similar properties, but not quite as fertile. The latter is, however, just as suitable for citrus, and as long as the physical condition is satisfactory the judicious application of fertiliser can correct any deficiency in the soil. If nutrients are supplied, light sandy soils, usually very poor, can give equally good results as loams, which are inherently more fertile. As previously stated, when deciding whether or not a soil is suitable for citrus, the factors which affect the physical condition are of far greater importance than the chemical properties.

Degree of acidity. The pH of the soil is not very important and citrus will, in fact, thrive equally well on soils of pH 4 as on soils of pH 8. The pH does, however, to some extent indicate how fertiliser is to be applied and what elements may possibly be deficient. Brack conditions may also be indicated by a high pH.

Alkali. The physical condition of alkali soils is usually unsuitable for citrus. Such soils, when once dry, do not readily absorb water and in some respects react in the same manner as very heavy clays. They are sticky when wet and become very hard when dry. Apart from this, they usually contain toxic concentrations of certain salts to which citrus is very sensitive. If fresh water is available, such soils may sometimes be reclaimed, though, as a rule, the process is tedious and difficult. Normally, therefore, they should be regarded as totally unsuitable for citrus cultivation.

Water supply

Quantity. Sufficient water should be available for irrigation, and the cost of bringing it to the particular site should not be prohibitive. Sufficient water should especially be available during the period July/August to March, since this is the blossoming and fruit-setting period. Provision should also be made for an adequate water supply during the remainder of the year so that the trees may be irrigated as soon as they begin to show signs of wilting.

It is difficult to prescribe the quantity of water adequate for a particular locality, since that largely depends upon the climatic conditions and the nature of the soil. In the vicinity of Nelspruit, where the average annual

rainfall is approximately 762 mm. (30 in.) with the distribution practically limited to the period November to March, irrigation during this period is unnecessary. From May to October, however, it is necessary to irrigate trees on sandy soil six to eight times as compared with two to three irrigations for trees on heavier soil. The water consumption under similar circumstances thus differs considerably, depending upon the nature of the soil. Usually sandy soils need a lighter irrigation than heavy soils, the former normally getting an application of 2 to 3 in. per irrigation. If there is no rain, it is usually necessary to water trees on sandy soil at least once a month and, if it is accepted that as much as 45,000 gal. of water per morgen are required for a 1-in. irrigation, one can form some idea of the amount of water that may be considered adequate.

Quality. One should satisfy oneself that the irrigation water contains no harmful quantities of alkali or other salts which may adversely affect the soil or the trees. If there is any doubt, it would be advisable to have the water analysed. In the case of borehole water one should be especially careful.

Other considerations

Apart from the above-mentioned points, there are other factors which cannot be dealt with in this article. There are, for example, the questions of the cost involved in erosion control, terracing and the preparation of awkwardly sloping areas, the accessibility of a particular place, the condition of the roads and the proximity of nearest station, store, house, school, town, etc. The attractions of a pleasant climate and beautiful natural surroundings have certain undefinable values which must be considered in completing the picture. If one intends to devote one's life to citrus cultivation, it is essential to choose well and correctly.

From ' Farming in South Africa.'

West African Cocoa Research Institute Appointment

Mr. J. Lamb, O.B.E., M.Sc., Director, Tea Research Institute, Ceylon, has been appointed Director, West African Cocoa Research Institute, and is expected to take up his new duties during the latter part of 1955.

English Agricultural Conference

A CONFERENCE on ' Combine Harvesting and Grain Storage ' organised by the National Agricultural Advisory Service was held at Chelmsford on December 2. It was attended by over 500 farmers.

Corn trade requirements

Col. J. F. Cramphorn, T.D., D.L., a corn merchant, was the first speaker and discussed ' Corn Trade Requirements.' He considered that the change in the pre-war and present-day function of corn merchants was a typical example of the adaptability shown by the agricultural industry during recent years.

Pre-war, the merchants were geared to handle a relatively steady but slow output of grain from the farms throughout nine months of the year. Premises, staff and transport facilities were designed to handle this type of business and purchasers of grain were usually supplied direct from the farm. Storage was virtually all on the farm, in stack, so the need for drying was not great.

In 1953, between 65% and 70% of the total grain crop of this country was offered for sale to corn merchants in the short space of eight or nine weeks after harvest and nearly every farmer demanded that his crop be moved off the farm at once. Since then the marketing of grain, although still covered by deficiency payments, has been freed from price control, and the 1954 harvest has been the wettest within living memory. As farmers had received good warning that freedom of marketing was coming, many wisely installed storage bins and are today independent of the necessity to sell their crop purely and simply on the ground of lack of space, and Col. Cramphorn considered that this was a tremendous factor favouring steady marketing.

During the 1954 harvest, many more acres had to be cut by a binder and stacked than farmers had planned for, and this misfortune had also inadvertently done much to steady the market. He considered that purchasing a combine was only one link in the chain of machinery requirements, and even if a drier and storage bin were not installed it was essential to provide a cleaning machine on the farm. He was offered sample after sample that badly needed cleaning and he thought that farmers must either accept a lower price to compensate for the purchaser's losses when he cleaned it, or must be prepared to send it to a neighbour or to a corn merchant for cleaning before offering it for sale; all this entailed a great deal of double handling and additional expense. He strongly recommended that a dressing machine be installed on every farm, and pointed out that the very fact of putting the corn through the machine took $\frac{1}{2}$% to $\frac{3}{4}$% of the moisture out and helped to bulk and make the sample more even.

Every combine should be operated by a fully experienced man; only too often badly threshed samples are obtained because the concave is set either too close or too far away and the setting may mean several shillings per quarter difference in the price obtained for the crop. Merchants are building more storage accommodation and so have improved facilities for bulking and reducing the double handling of the crop. Col. Cramphorn considered that in the future all grain would be handled in bulk with considerable saving of labour and expenditure, but he stressed the fact that bulk handling, to be successful, should take place at the premises of both the producer and the consumer.

Combine harvesting and drying

Discussing ' Combine Harvesting and Drying,' Mr. J. Mackie, of Kincardineshire, Scotland, said he hired a combine in 1938 and cut oats which were too green. In 1943, he bought his first combine and since then has increased the acreage combined each year. In 1947, he commenced farming in Lincolnshire and in 1952 extended his activities to Essex, where today he combines up to 300 acres annually. To combine oats they must be very ripe indeed, and he found that the variety Onward was very satisfactory. Proctor barley, when grown in Lincolnshire and Essex, laid badly, but proved very successful in Scotland.

The stiff-strawed varieties of wheat like Cappelle II and Hybrid 46 did well in the South, while in Scotland Bersee had proved very useful.

Mr. Mackie felt that combines specially designed for harvesting cereals under English conditions were needed, as American makes did not seem to be wholly satisfactory. The N.I.A.E. is at present working on combine design on the basis of rubbing the cut crop with rubber belts, and this method seemed to have possibilities for the future.

The policy of burning straw on the field, as practised in the Eastern Counties, was criticised and the speaker recommended all cereal producers to use their straw for feeding livestock. The resulting muck would do much to build up fertility.

Grain storage

Mr. H. Hollinrake, Provincial Farm Buildings Advisory Officer A.L.S., stressed the need for farmers to plan carefully their layout before investing in grain storage equipment. If, for example, grain was being delivered from the field at the rate of 4 tons per hour, the dresser must be capable of handling a similar amount, or suitable accommodation like a holding silo should be provided as a buffer between field and storage operations. Similarly, if it was visualised that two kinds of grain might be harvested at the same time, it would be necessary to provide dual pits, silos, or perhaps a divided silo.

The major fault with silos used for drying is failure to make sure they are airtight. Concrete blocks vary enormously in quality—some are tight and dense, some are very porous—and, although there is a British Standard Specification, some manufacturers still produce inferior quality products. If after purchase the blocks are found to be porous, some farmers put on a rendering consisting of two and a half sand to one cement, but the use of such a rich mix has proved to be wrong. Mr. Hollinrake recommended a mix of eight sand, two cement and one lime as being ideal. If water seeps through inside the blocks it can then evaporate easily through the weak mix on the outer surface by the action of the wind and sun. Another method of rendering the silo watertight is to apply two coats of bitumastic paint on the inside wall. If water penetrates through the blocks, it cannot seep through the bitumen layer and will eventually evaporate. The bitumastic paint, however, must be applied some time before the silo is used to avoid grain sticking to the surface wall.

Discussing in-bin drying, Mr. Hollinrake said that many farmers blew cold air through the bins at the wrong time, *i.e.* in periods of high humidity, and when this is done it is quite likely that the moisture content of the grain will be increased. There is a danger also that the grain will expand and in some cases silo walls have been pushed out.

The precast round concrete silo used to be the cheapest form, but two types of manufactured square concrete silos are now available and are superior. There is little to choose between the square precast concrete bin and the square steel bin, both being satisfactory. Just recently square plywood bins have been put on the market and are cheaper in price. Outdoor silos have given every satisfaction. Little or no condensation has occurred, but the cost of erecting a roof and standings makes the ultimate cost more than when erecting the silos under a dutch barn.

Discussion

At the close of the talks, the three speakers joined the chairman, Mr. J. Matthews, on the platform and a lively hour's discussion took place, when a wide variety of questions were dealt with.

WORLD CROPS

IN OUR NEXT ISSUE there will appear a report on the position of **Cocoa in Bahia, Brazil,** by D. H. Urquhart and G. A. R. Wood. Problems involved in the extension of **Maize Cultivation into Northern Temperate Regions** will be discussed by John L. Harper, while J. McCloy will deal with the **Artificial Drying of Crops in Remote Territories.**

Christmas Acknowledgements

We have received, during Christmas, cards, calendars and diaries from the following:

West African Institute for Oil Palm Research, Shell Petroleum Co. Ltd., Shell (Research) Ltd., Kipp Kelley Ltd., Monsanto Chemicals Ltd., The Hunting Group of Companies, A. E. Haarer, Universal Crop Protection Ltd., Sidney-Barton Ltd., Pest Control Ltd., Imperial Chemical Industries Ltd., Massey-Harris-Ferguson Ltd., Ford Motor Co. Ltd., Rotary Hoes Ltd., National Institute for Agricultural Engineering, R. W. Gunson (Seeds) Ltd., Plant Protection Ltd., Dorman Sprayer Co. Ltd., Eleanor and Phil Singleton, James A. Hodgson Ltd., The Squier Corp., Opancol Ltd., R. Leibman, Whitlock Bros. Ltd., Diamond Alkali Co., International Harvester Co., Willsmore and Tibbenham (Norwich) Ltd., Aerofilms Ltd., Scottish Mechanical Light Industries Ltd., International Potash Institute, Birtas Galata, Caterpillar Co., Inter-African Bureau for Soils and Rural Economy, Chronica Botanica Co., and FAO.

We acknowledge these with many thanks.

Kapok

Continued from page 73.

times used as supports for the pepper plant and thus they serve a dual purpose.

Summary

Indonesia is the leading producer of kapok and exports floss which fetches the highest price. The true kapok, *Ceiba pentandra* Gaertn, is an easy tree to grow in warm tropical lowland regions where the rainfall is low and somewhat erratic and the soil is a sandy loam. Kapok trees are useful on peasant holdings, since they need little care when once they are established and the crop may be harvested or neglected in accordance with the rise or fall of world prices. The oil is procurable from the seed, the press cake is valuable as a manure and the timber has its uses in regions where forest trees are few and far between.

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CORRESPONDENCE

Mauritius Sugar Industry Research Institute

TO THE EDITOR

Dear Sir,

A note on the recently created Mauritius Sugar Industry Research Institute, which appeared in WORLD CROPS for December, has caused a certain amount of uneasiness concerning the doubts which your correspondent expresses as to the necessity of the transfer of research work on sugar cane from Government to the sugar industry. I refer more particularly to the following passages:

> ' One cannot but wonder exactly what reasons led to the somewhat surprising change which its foundation involves.'
>
> ' In the circumstances it is a trifle difficult to appreciate the reasoning which led the Economic Commission of 1947 to recommend the retransference of the work on sugar cane from the Government to the sugar industry.'

As you are no doubt aware, the former sugar cane research station was almost completely depleted of senior staff between the years 1946 and 1952. Government endeavoured to remedy this situation, but was unsuccessful, probably because of the salaries attached to the posts. Such an unsatisfactory state of affairs was bound to have serious repercussions on the volume and excellence of work performed, and hence on the progress of the sugar industry.

As a consequence, the Government of Mauritius and sugar producers viewed the position with concern, and after exhaustive study of the problem came to the conclusion that the industry itself should run its own research.

The advantages of a research institute run and administered by the industry has obvious advantages, as it offers more flexibility both as regards finance, including the recruitment of staff, and orientation of research. It is probably such desirable features which prompted many industries in widely scattered lands to organise and administer their own agricultural research. Indeed, I believe that the modern trend is for the development of commodity research stations financed and administered by the industries they serve.

I might also mention that during his recent visit to Mauritius Sir Geoffrey Clay was favourably impressed by the organisation of sugar research in Mauritius and expressed the view that sugar producers of the island should be congratulated in deciding to assume the responsibility of financing and administering scientific research in the various fields of sugar production.

In the circumstances I should be most grateful if you would kindly insert a note in one of the forthcoming issues of WORLD CROPS bringing to light the facts set forth above, as the article I refer to may throw involuntarily a shade of discredit on a research organisation which is of primary importance to the economy of Mauritius, and which we are all endeavouring to make as great a success as its predecessor.

Yours faithfully,
P. O. WIEHE,
Director.

Mauritius Sugar Industry
Research Institute,
Réduit,
Mauritius.
December 10, 1954.

We are glad to have received this letter. We may point out in justice to our reviewer that his query depended upon the fact that the original transfer of the research work on sugar cane from the old Station Agronomique to the Government in 1912 *on the recommendation of the Royal Commission of* 1909, *had given most satisfactory results, as witness the remarkable increase in sugar production in Mauritius of late years. It now seems that the change was mainly due to the inability of the Mauritius Government to pay salaries of the order necessary to attract scientific personnel of the required calibre. This was not appreciated at the time the note was written, nor was the fact that the sugar research station had been almost depleted of senior staff between* 1946 *and* 1952. *It seems a fitting commentary on the traditional hesitancy of Governments in general to appreciate the need for paying adequate salaries to scientific officers.—Ed.*

Who Invented Incrossbreeding?

TO THE EDITOR

Dear Sir,

As in parts of America, a steadily increasing number of commercial poultry keepers in the United Kingdom today are utilising incrossbred stock for the production of eggs and even table birds. Some of them have begun to ask what is the difference between an incrossbred and an ordinary crossbred fowl. The usual answer explains the facts, but goes on to add that this ' new ' system of poultry breeding was originated about the end of World War II by Henry Wallace, jun., in Iowa, who applied to poultry breeding the methods which his renowned father had so successfully employed in the production of commercial maize seed. And that is as far as the average man can get at present—that all the credit goes to Henry Wallace, sen.

No one would deny the remarkable success of the latter's work or the promise of his son's. But does the history of incrossbreeding really begin with maize? Where, in fact, did it begin? My memory, alas, is not what it was, but I have recollections of a revolutionary ' new ' Dutch sugar cane in Java (was it POJ2878?) some 25 to 30 years ago, and I am now wondering whether this, too, was produced by incrossbreeding and, if so, whether it was the real pioneer. I should be grateful if you or your readers could enlighten me on the subject.

Yours faithfully,
G. E. MANN.

' Huntingdone,'
St. Michaels,
Tenterden, Kent.
November 28, 1954.

' Incrossbreeding ' means the mating of highly inbred lines of different varieties or breeds in the hope that the progeny will show better phenotype performance than normal commercial seed or stock. The material distributed to purchasers is highly heterozygous as a result of this search for heterosis (' hybrid-vigour ') and is normally unsuited to further breeding inter se.—*Ed.*

Testing of Spraying Nozzles in the Field

TO THE EDITOR

Dear Sir,

Dr. Vanderplank's account* of his work using a variety of spraying machines to cope with a specific problem illustrates the valuable advantage of speed which the straightforward method (of choosing the best machine) has relative to our analytical approach at the N.I.A.E. I should, however, point out the need for caution in drawing conclusions from empirical work.

The facts may be summarised: a ' Micron ' spraying machine knocked down very many more insects per unit consumption of insecticide than alternative spraying machines. This he interprets as evidence that the rotary nozzle used on this spraying machine is very much superior in practical performance to the nozzles used on the other machines involved in the comparative test in saying, ' I have found that this type (spinning disc) is far superior to any others which I have tested.'

But the comparison was made, not between nozzles, but between, on the one hand, a rotating nozzle together with a fan to rotate it and to propel the spray to a distant target with, on the other hand, hydraulic sprayers carried into the crown of the palm tree and used there to apply a surface deposit. There is no evidence here to indicate what would have happened if another nozzle had been used, in place of the ' Minimicron ' nozzle, to spray into the air stream.

The very great difference in the performance of the mistblower and the hydraulic sprayers is dependent upon:

1. The drop spectra of the nozzles of the two machines.
2. Whether or not the spray ever reaches the general target—the top of a tall tree.
3. Whether or not the spray reaches an insect, presuming it is able to reach the tree top.

Only the first of these is evidence for or against the suitability of *the nozzle alone*. It is only in terms of the drop spectra obtained from them and in practical details that the controversy over the relative merits and scope for use of different nozzles can be considered.

*World Crops, December 1954, p. 488.

As I pointed out in my letter to World Crops (5, 468, 1953)—following similar criticisms of my contention that rotating nozzles are, within the general spraying problem, a specialist nozzle—the drop spectrum obtained from rotating nozzles under practicable operating conditions is *not a prerogative of this type of nozzle*.

Rotating nozzles can give a narrow range of drop sizes, but only at extremely low flow rates. The drop spectrum obtained from the ' Minimicron ' at a flow rate of 100 ml. per minute is not dissimilar to the drop spectrum obtained by causing liquid to flow at the rate of 800 ml. per minute through a smooth tube inserted at right angles into the stream of air from a fan, allowing the air alone to cause the break up.

Table 1

Drop size, microns	I	II
0.0– 8.5	0.0	0.0
8.5– 17.0	0.6	0.0
17.0– 25.5	1.7	2.0
25.5– 34.0	7.3	10.0
34.0– 42.5	9.5	14.9
42.5– 51.0	21.8	14.1
51.0– 59.5	11.2	15.5
59.5– 68.0	12.3	13.3
68.0– 76.5	12.3	8.7
76.5– 85.0	9.5	6.3
85.0– 93.5	6.1	4.2
93.5–102.0	3.4	3.2
102.0–110.5	1.1	2.3
110.5–	3.4*	5.5*

*Over 110.

I. ' Minimicron ' spraying dyed water at 100 ml. per minute from Dr. Vanderplank's Table 3, column No. 1.

II. A plain brass tube injecting dyed water into an air stream (moving at 190 m/h.) at the rate of 800 ml. per minute.

Therefore, if a fan is used on the spraying machine the choice lies between an air-driven rotating nozzle and, for example, a piece of pipe or another nozzle able to form the required drop spectrum. If, on the other hand, the spraying machine does not use a fan, and the great majority do not, this rotating nozzle is automatically excluded. This exclusion and the inability of rotating nozzles to provide, under practical operating conditions, a performance different from that of other nozzles limits the number of applications where it is both acceptable and capable of giving a superior performance to that of the alternatives available.

Any other consideration of relative merit depends upon practical advantages of versatility, freedom from blockage or wear, cost and ease of maintenance, for examples.

On the point of versatility, Dr. Vanderplank states that ' for insecticides and emulsions, suspensions and wettable powders in water three or four types of nozzle would be required to handle these different types of insecticidal formulations.'

If we consider any two of these which are not synonyms or alternative generic terms, emulsions and suspensions, for example, it is incorrect to say that airblast nozzles will not handle both. Many hydraulic nozzles will handle both also. If freedom from wear is the primary criterion of how good a nozzle is, then the rotating nozzle is superior to most nozzles.

Thus I cannot argue the value of a nozzle except within prescribed limits which define the standards of merit of a nozzle. The efficient knock down of the pests is, in the example given by Dr. Vanderplank, valuable evidence of how good a mistblower can be, but the conclusions drawn from the experiment would have been valid only if the suitability of the ' Minimicron ' nozzle had been dissociated from the performance of the fan used to propel the spray formed by this nozzle to the target.

Finally, I wish to avoid giving the impression that I necessarily hold contrary opinions to those held by Dr. Vanderplank, as the ' Minimicron ' nozzle may be a very good one in a variety of circumstances. But I do not think that his analysis of the evidence which leads to the implied conclusion that the ' Minimicron ' nozzle is the *only one* which is good for his purpose is rational or that the conclusion is correct.

Yours faithfully,
R. J. COURSHEE.

National Institute of
Agricultural Engineering,
Wrest Park, Silsoe,
Bedfordshire.
December 6, 1954.

Frazar and Hansen Offer

Messrs. Frazar and Hansen, manufacturers and dealers of farm machinery and equipment in California, inform us that they are anxious to appoint sales representatives in overseas countries. Their address is Clay at Front Street, San Francisco 11, California, U.S.A.

RESEARCH DEVELOPMENTS

Water and Plant Growth

The 7th Amos Memorial Lecture at East Malling

THE 7th Amos Memorial Lecture was given by Prof. T. A. Bennet-Clark on November 25 at East Malling Research Station. His subject was 'Water and Plant Growth' and he began by giving a brief historical review of experiments on the importance of water to plants. Thus in 1610, Van Helmont concluded that the plant body was composed entirely of water or material formed from water when he found that a 5-lb. willow plant in 200 lb. of dry soil gained 164 lb. in five years while being fed with pure water only. Although his conclusion is now obviously wrong, water is more important in plants than in animals. In both it is the medium for chemical change, but in plants it provides mechanical strength in living tissues that are not woody and it also is required in the growth of the plant cell.

Our understanding of these functions of water in the plant is based on the work of many people, including Robert Hook, who was one of the first people to use the microscope and who gave the name of ' cell ' to the box-like structures that he saw; Nathaniel Grew, who was the first great anatomist; Moldenhawer, who about 1800 studied individual cells obtained by macerating tissue; and Dujardin, who in 1830 recognised that the walls of cells were a non-living skeleton with the living protoplasm inside. Living cells are roughly brick shaped and a mass of such cells is called parenchyma, a name coined by Grew.

Osmotic pressure

At one time, the cell was considered as having a tough non-living wall with a *lining* of living protoplasm. By suitable treatment the protoplasm can be plasmolysed, *i.e.* made to retract from the cell wall. This phenomenon was investigated 150 years ago, using a model plant cell made from a pig's bladder. This and more accurate experiments 50 years later showed that pressure was developed inside the membrane when a suitable solution was put on one side of the membrane and water on the other. The process is explained by the property of molecules to move from a crowded to a less crowded phase. The movement can be checked by compressing the solution so that the molecules are more crowded, and when the pressure applied is just sufficient to prevent water entering the solution, the pressure is called the ' osmotic pressure ' of the solution. The classical view of a cell was that it was a bladder of protoplasm blown up against the cell wall by the osmotic pressure of the solution inside, rather like the bladder inside a football.

Plasmolysis

There are, however, certain dyes that cannot penetrate into the protoplasm in a plasmolysed cell, although they do pass through the cell wall and colour the space between the protoplasm and the cell wall. Some cells have thick walls and they clearly show that in an unplasmolysed cell the dye remains right *outside* the wall. This shows that the protoplasmic membrane that offers resistance to the passage of solutions must be at the outside of the wall, filling tiny spaces in the cellulose of the wall and not, as was assumed, inside the wall. When the cell is plasmolysed and protoplasm is pulled out of these interstices and the protoplasmic surface exposed to the passage of liquids is increased.

Water cohesion

Although the cells of the leaves of trees do not appear to have water outside them, they plasmolyse in strong solutions and it is commonly considered that the cell walls are full of water. The leaves lose water by transpiration and this loss is made good by water passing up the trunk from the roots. The simplest theory of how this occurs is illustrated by a model consisting of a porous pot full of water attached to a long tube dipping into a dish of water. Evaporation from the surface of the pot draws water out of the tube and as the molecules of water cohere the whole column is drawn up. To establish this theory it is necessary to show that water cohesion is sufficient to support a column of water as high as the tallest trees. This is estimated at some 10 atmospheres tension and Dixon and Joly found by experiment that water could stand some 50 to 100 atmospheres.

Difficulties of the cohesion theory

The lecturer then discussed some of the difficulties in the Dixon cohesion theory of water movement. Although many experiments support the theory and show that the upward movement does not depend on the trunk being alive, they were done on trees and branches that were cut, and something quite different may happen in an uncut tree. Thus if a skyscraper were cut across and water flowed down the lift shaft it would be dangerous to assume that the lift shafts were the usual channels of water transport! The cohesion theory requires the vessels to be full of water under tension, but if the stem is cut, air would rush in, making the examination of the natural contents of the vessels difficult.

Two methods of getting over this difficulty have been tried. In one, the stem is frozen in liquid air before cutting up and is then thawed under liquid, when, if the theory is right, the liquid should be drawn in to fill all the spaces. But this experiment showed most of the vessels to be full of air. In the second experiment, a cup of indian ink was arranged against the peeled cambium and a cut made through the ink into the wood. The indian ink was drawn into the vessels, but went much further and more rapidly than was expected on the basis of the cohesion theory. This result suggests that the vessels contained air under reduced pressure (about half an atmosphere) and agrees with the result from the frozen trunks. Both experiments suggest that the necessary tensile columns of water do not exist. Moreover, Dixon and Joly's figure for the tensile strength of water is subject to considerable question.

Further evidence

Further evidence against the theory was provided by an experiment done on orange trees in Israel. Here two saw cuts were made from opposite sides of the tree, extending beyond the middle and thus severing all the tensile water columns; but the tree did not die and its transpiration rate was almost normal. When the experiment was repeated at Leeds a seasonal effect was found; no injury was caused by cutting while growth was beginning in the spring, but if the cutting was done while the buds were dormant they failed to open till August or September. A study of this phenomenon might yield results that would help in slightly delaying blossoms to avoid spring frosts.

The indirect path followed by water when the normal direct path was damaged was studied anatomically and it was found that new xylem (wood) elements were laid down horizontally, bridging the interruption to water transport. The live young xylem vessels consist of columns of parenchyma cells and there would be no tensile column of water; the cell contents would, in fact, be under a slight positive hydrostatic pressure.

Conclusion

In summing up, the lecturer put forward the view that both young living parenchymatous xylem and dead vessels play a part in water transport, with possibly the living xylem being the main channel in spring and the dead vessels in late summer. Furthermore, it is probably about 100 times easier for water to pass from one living parenchyma cell to another than to a dead space. These suggestions are further supported by experiments with radioactive isotopes in the water stream. The isotopes were found to collect close to the cambium and not in the older vessels.

Prof. Bennet-Clark concluded by discussing the advantages of using established trees for research on water movement and urged that the subject should be studied at East Malling, where many experimental trees were available.

A vote of thanks to Prof. Bennet-Clark, proposed by Dr. D. W. P. Greenham and seconded by Mr. Peter Wheldon, was enthusiastically carried.

Australian Agricultural News

From our Australian correspondent

Sugar and rice research

Excellent growths of sugar cane and encouraging results from rice-growing trials have been reported from the Kimberley research station on the Ord River in the north of Western Australia. Announcing this recently, the Director of Agriculture in Western Australia, Mr. G. K. Baron Hay, said that extensive experimental work was being carried out on the station by officers of the department and the Commonwealth Scientific and Industrial Research Organisation. Eight types of sugar cane were being treated in the variety trials and in five months the plants had grown to a height of 8 ft. In other experiments to determine most suitable planting times and fertiliser treatments some plants had reached a height of 12 ft. and showed little damage from pests or diseases. Mr. Hay said that the director of the station, Mr. L. C. Lee, had made some encouraging reports on the growth of rice. Some of the tested varieties had given excellent results, but finches caused serious damage in the experimental plots and might present a problem in the area. Fibre plants, including jute, roselle, kenaf and cotton, were being grown and the results of these experiments were being awaited with keen interest. Cotton plants looked healthy and were a good colour. So far pest damage had been slight. Other experimental plantings included peanuts, sunflowers, sorghum, finger millet and cowpeas.

Sorghum

Considerable increases in the acreage sown to grain sorghum are expected in New South Wales this year. The sorghum expert of the New South Wales Department of Agriculture, Mr. L. R. Kavanagh, said recently that there is a marked increase in sorghum in many of the districts in the state. Where the weather had prevented farmers from sowing on large areas prepared for wheat, much land will probably be used for sorghum crops. ' Grain sorghum is fairly resistant to drought,' Mr. Kavanagh said. ' It can stand rainless periods and then recover remarkably when the rain does come. That is why it is so suitable to the north-west. It can stand conditions too dry for wheat or maize. At the Yanco experimental farm it has been shown that yields of up to, and over, 100 bushels an acre can be obtained consistently. Variety and cultural trials there since the war have shown considerable advances in techniques of growing sorghum under irrigation. Last year the commercial crops averaged yields of 50 to 60 bushels an acre. This year sorghum will have particular interest there, as rice areas may be reduced because of the water shortage.'

Wheat harvest

Prospects for the coming New South Wales wheat harvest appear to be little better than in the drought years of 1940-41 and 1944-45, according to that state's Department of Agriculture. The harvest in 1940-41 was 24 million bushels, and in 1944-45 it was 17 million, compared with 45 to 50 million bushels in a normal year. It is stated that at no time during the growing season have crops been in a sound position, but before the advent of longer days and higher temperatures there was still hope of a fair recovery. The possibility of a good recovery, other than in late districts, has largely passed. As crops have not had a chance to develop root systems and become established properly, even with favourable weather from now till harvest, no spectacular recovery can be expected. The long-awaited general rainstorm which could have saved many crops has not materialised. Stock have been turned into a number of crops, and unless there is immediate relief many more will be used for this purpose. Pasture growth is very poor, and where feed is scarce farmers consider it better to keep the stock in sound condition and graze off the crops.

Prof. R. E. D. Baker

We regret to record the death on November 19 last of Prof. R. E. D. Baker, Professor of Botany at the Imperial College of Tropical Agriculture. Prof. Baker had filled this post since 1945 and was well known for his work there. He was an acknowledged authority on various tropical crops, notably cocoa and bananas.

NEW BOOKS

Tomato Growing

By F. W. Allerton. Pp. 196. Illustrations. Faber. 18s.

The tomato has for long been the staple glasshouse crop. Its nutritive and vitamin value, coupled with its versatility in use, has always ensured a high return per unit area of ground and, though prices certainly fluctuate widely, yet the marketability of the crop is always assured, unlike that of many other horticultural crops. In war-time the tomato was the only crop for which the heavy expenditure of fuel and labour inherent in glasshouse culture could be justified and the removal of all foreign competition and the demand for tomatoes as a pleasant and valuable addition to a dull diet meant high profits to the grower. Since the war, however, steadily rising costs of production, together with the price-lowering effects of imported produce, have meant that yields must be pushed ever higher if a reasonable profit is to be assured.

So much capital is involved in the glasshouse industry that it is not surprising that much research has been devoted to the improvement of tomato yields and to the development of labour-saving techniques to reduce the cost of production.

The author of the present book, a graduate in horticulture who has had great experience of tomato growing in all parts of the country as chief technical adviser to one of the largest wholesale firms and suppliers of sundries, has written a most valuable and up-to-date book, embodying the accumulated practical skill of many growers, together with the most modern scientific advances. The subject is exhaustively treated from the preparation of the borders to the stage of ripe fruit. It should be pointed out that the title is literally true; the author is concerned only with the growing of the crop and deals not at all with grading, packing or marketing, although with his wide experience such treatment might have been very valuable.

The book is intended essentially for the commercial grower and would be of little value to the amateur. Any grower, however progressive and up to date he may be in his methods, will find in it much that is helpful and informative. The book is written from the scientific viewpoint and attempts, so far as present knowledge allows, to give a reasoned explanation of technical practices.

The photographic illustrations are well chosen to be really helpful and are not merely embellishments intended to increase the sales value. The book is a valuable addition to the publishers' series of horticultural manuals.

R. H. STOUGHTON

Methods of Crop Forecasting

By F. H. Sanderson. Pp. 259. Harvard University Press. London: Geoffrey Cumberlege. 1954. 40s.

In this very concise and well-written book the author presents a summary of the wide and scattered literature on crop - forecasting methods, subjects recent advances in this field of study to critical appraisal, studies the relations between different approaches to the subject, evaluates their relative merits and arrives at a general view of the various aspects of the problem. As no firm basis of reliable long - range weather forecasts has been found, he confines his study to methods of short-range forecasting which do not involve weather, except by taking into account such inter-correlations as may exist between the weather observed up to the date of the forecast and subsequent weather conditions.

The logical processes involved in statistical prediction are examined and attention drawn to limitations and pitfalls of correlation technique. Subjective methods of estimating and forecasting acreage, based on reports, and of objective methods involving frontage measurements, aerial surveys, economic and meteorological factors are also studied. The author shows how reports from crop correspondents can be made more accurate by adjustment for bias and other factors. A description is given of objective methods involving the application of sampling techniques to the measurement of the growing crop. Finally, Dr. Sanderson examines and summarises some current theories on the influence of weather factors on plant growth and yield.

For a proper appreciation of the merits of this book a knowledge of modern statistical theory is essential. How far these methods are applicable to forecasting, however, must depend on a more complete understanding of factors underlying plant growth. Economists were amongst the first to appreciate the opportunities of applying statistical theory and technique to crop forecasting, but it is evident that without greater knowledge of plant growth and of the characteristics of growth which are correlated with yield, together with more comprehensive phenological records, a limit is set to the usefulness of modern statistical techniques for crop forecasting. In these respects data are sadly lacking. This is time and again emphasised by the author, who states *inter alia:* ' Frequent failure in projecting these formulae have emphasised the need for a thorough study of the plant and its environment and a careful statement of the hypotheses which are to be tested against such independent evidence as may be available.'

However ingenious the formulae used, successful crop forecasting can never depend solely on a statistical basis. The statistician must possess an adequate personal knowledge of the soil types, the topography, agricultural methods used in the area, as well as knowledge of the crop under review. It is only by the possession of this information that he may, in the words of the author, ' interpret the reported condition in such a manner as to correct not only for any failure of the condition figures to represent the true appearance of the crop, but also for any failure of the appearance of the crop to reflect the prospective yield.'

D. H. GRIST

A Dictionary of Dairying

By J. G. Davis, D.Sc., Ph.D.(Lond.), F.R.I.C., M.I.Biol., F.R.San.I. Pp. 1132 + xxvii. Second edition. London. Leonard Hill Ltd. 1954. 65s.

The first edition of Dr. Davis's ' Dictionary of Dairying ' was published in 1950. At that time, it was welcomed by the dairy industry in many countries. Five years have elapsed since the first edition was published and in the interval some important advances in knowledge have occurred, while the headway inevitably

lost during the war years has been recovered. On this account, the demand arose for a second edition of the dictionary and this has been met by the present publication.

The new edition represents a re-writing of much that appeared in the earlier edition, while a very large amount of new material has been added. The total number of pages has been increased to 1,132 and specially contributed additional articles appear on 57 different subjects which were not found in the earlier edition.

Much of the new writing has been assigned to a larger number of distinguished authorities on the dairy industry; the author is to be congratulated on the result, which may truly be described as a monumental effort covering every aspect of dairying.

As an example of the thoroughness with which the subjects have been treated may be mentioned the article on ' Mechanical Handling in the Dairy Industry,' which is the work of W. W. Ritchie, B.Sc.

Space does not permit a full list of the specially contributed articles to be given, but the following shows some of the more important subjects which have been treated: ' Effluents in Dairies ' (L. A. Allen, D.Sc., Ph.D., F.R.I.C.); ' Milk Constituents in Breadmaking ' (A. J. Amos, Ph.D., B.Sc., F.R.I.C.); ' Legal Aspects ' (A. L. Barton and P. O'Neill, B.A., B.C.L.); ' Retail Dairying ' (S. Clifford, B.Sc., A.M.I.Mech.E.); ' Packaging of Dairy Products ' (J. G. Huntley, B.A.). In each of these articles the subject is fully dealt with, treatment running usually to a number of pages.

Dr. Davis himself writes with authority on a vast range of subjects, including such topics as Renazurin tests, cheeses, and a number of other subjects, including a lengthy section on the various aspects of pasteurisation, in which he is assisted by contributions from a number of other workers.

Space does not permit mention of the numerous other subjects that are dealt with.

The articles that appear in the dictionary are in all cases clearly worded and informative.

The book itself is well produced; it should find a place on the desk of all connected with the dairy industry. It is, in fact, an invaluable work of reference on an important subject.

A. M. L.

The Pruning of Fruit Trees

By Paul Champagnat. Translated and edited by N. B. Bagenal. Crosby Lockwood. 12s. 6d.

The original French edition on which this book is based was hailed when it appeared in 1950 as the ' most complete and important book on the pruning of fruit trees so far published in any language.' The contents were arranged in sections, dealing first with the various parts of the tree, their development and function, and with pruning in general, then with shaping the so-called ' natural ' and ' artificial ' forms, and finally with pruning for fruit production. Bagenal has retained the general arrangement of the original, skilfully picking out of each chapter the parts most likely to interest the English reader and omitting the more theoretical discussions. Here and there one can spot an awkwardness of construction that comes from too literal translation and occasionally one can quarrel with the choice of word used for the original French term. Thus ' dehorn ' seems inadequate to convey the meaning of ' élagage,' which, according to figure 7, denotes mainly branch thinning. The English term ' short spur ' pruning denotes something more severe than the three-bud method it is used to describe and a better equivalent for the French ' trigemme ' would be ' long spur ' or simply ' spur ' pruning. Although there are other similar examples, ambiguity is usually avoided by the illustration of each term or operation.

Although space is devoted to commercial shapes, open centre trees and pyramids (central leader trees of various types) formed by French and American methods, more attention is paid to the artificial forms, dwarf pyramids, winged pyramids, goblets, espaliers, simple and compound cordons, and palmettes. The up-to-date descriptions of the Lorette system, arching, and the spindle bush form an important part of the book. On the whole, few of the methods described are likely to interest the commercial grower in this country, as he can obtain better guidance on pruning in books already published, but some of the detailed operations may stimulate him to try modifications of accepted methods. The grower of intensive fruit, and especially the amateur, will enjoy the simple directions given and may be encouraged to depart from the simple garden forms now used so successfully to try arching and ' runaway ' palmettes instead. The modest price of the book should bring it within the reach of all.

H. B. S. Montgomery

Research in Forestry and Forest Products

FAO Forestry and Forest Products Study No. 9. Pp. 323. Rome, Italy. Food and Agriculture Organisation of the United Nations. 1953.

The publication is a useful directory of the main forest research centres of the world drawn up with the help of the International Union of Forest Research Organisations. It is the more useful in that it gives, where available, the names and addresses of subsidiary research bodies that are not widely known outside their own countries.

At the beginning the objectives of the research are stated, covering the whole field of forestry. Among these under silviculture a new term is introduced, ' harvest cuttings,' which does not appear in the English terminology and has no clear relation to the term ' silvicultural systems,' with which it seems to be synonymous, and it is hard to see how it is an improvement on it.

The tabular index on page 15 of the countries reporting is interesting as showing at a glance what objectives are being studied in each country and the United Kingdom can feel flattered that, next to the United States, it covers the most subjects.

The bulk of the publication is taken up with the actual directory and project summaries as given in the answers to the FAO questionnaire.

The information given is copious and the wording might perhaps have been cut down without loss of clarity and thus given more space for fuller treatment of items of special interest to any particular reporting country. There is a handy subject index.

The book should find a place in all forest research and forest school libraries.

W. A. Robertson

FARM MACHINERY

Nubrex Lubricator

Messrs. Ch. J. Neuman Ltd., of South Croydon, Surrey, have just designed the latest ' Nubrex ' economy lubricator which is now in production. Special features of the new lubricator are the ingeniously constructed lid of solid steel which can be clipped straight on to standard size grease kegs of 28 lb. or 40 lb. capacity with three adjustable clips. The pump unit incorporated in this lid is so constructed that one stroke completely fills the 10-ft. reinforced rubber hose, which carries a booster at its other end. Exerting a guaranteed pressure of 7,500 p.s.i., this pump is stated to give 30 to 40 satisfactory greasings at various points of any machine or structure.

Experimental Mulching Machine

In an effort to reduce the number of costly operations usually required to prepare a pineapple field for planting, the California Packing Corp. in Hawaii has developed a mulching machine that combines these tillage practices into one pass over the field.

The mulching machine is basically formed around a Caterpillar D8 track-type tractor. It is designed to enter a field after a stump cutter has thoroughly chopped up an old field of pineapple plants and completed all tillage operations in one pass to make ready the field for planting.

On the front of the tractor is mounted a trash rake, powered with the tractor's hydraulic unit to clear to one side the mat of trash left on the field by the stump cutter. Two p.t.o.-driven rotary tillers, mounted on the rear, thoroughly stir up the soil down to a depth of 14 in.

Fumigating and fertilising equipment make up the rest of the 20,000 lb. of farming tools that have been attached to the diesel tractor framework. A rear-mounted float completes the operation, smoothing the area for planting. All told, the mulching machine weighs close to 30 tons. It travels only in low gear when preparing a pineapple field for planting and can work an area of approximately one acre per hour.

According to the California Packing Corp., the mulching machine is still in an experimental stage. Test results are awaited in anticipation of building more similar machines. Hopes are high that this once-over operation with the heavily equipped track-type tractor will cut tillage costs considerably.

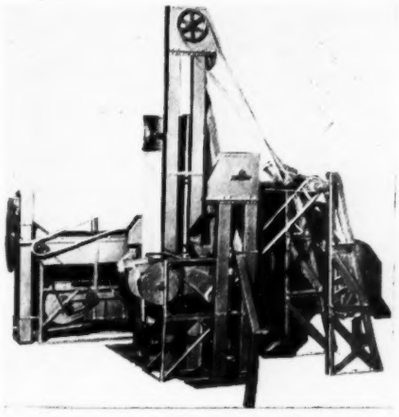
Packman Potato Harvester

Results of large-scale potato harvester tests are embodied in the Packman potato harvester, which was shown at Smithfield in December by the agricultural division of Thomas Storey (Engineers) Ltd. Carried out during the 1954 harvest on almost every type of soil and growing conditions throughout the United Kingdom, the tests involved the use of over 30 machines.

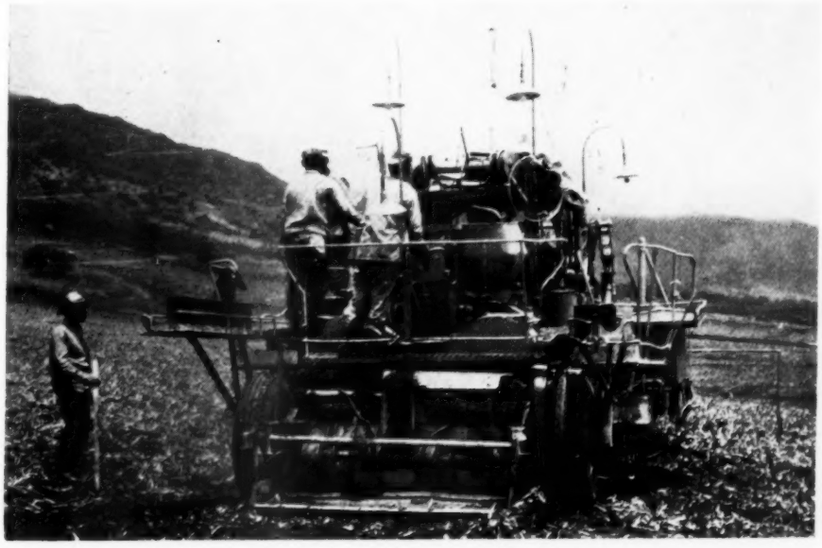
Throughout the world there are many potato-growing areas where the top soil, and particularly the subsoil, is of such a character—gravel, chalk or stone content—that, no matter what the moisture condition of the top soil, the potato harvester, mounted on pneumatic wheels, will maintain a constant depth level and not subject the farmer to the inconveniences of sinking, involving constant machine adjustment.

There are, however, many other potato-growing areas where, by reason of deep tilth and soft subsoils—loam,

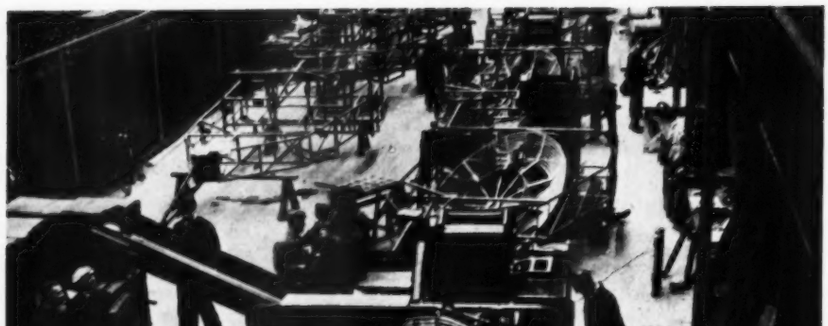
The ' Nubrex ' lubricator



This model of the Lincoln Mark II grain drier installation was exhibited on the stand of Penney and Porter Ltd. at the Smithfield Show



The experimental mulching machine formed around a Caterpillar D8 tractor



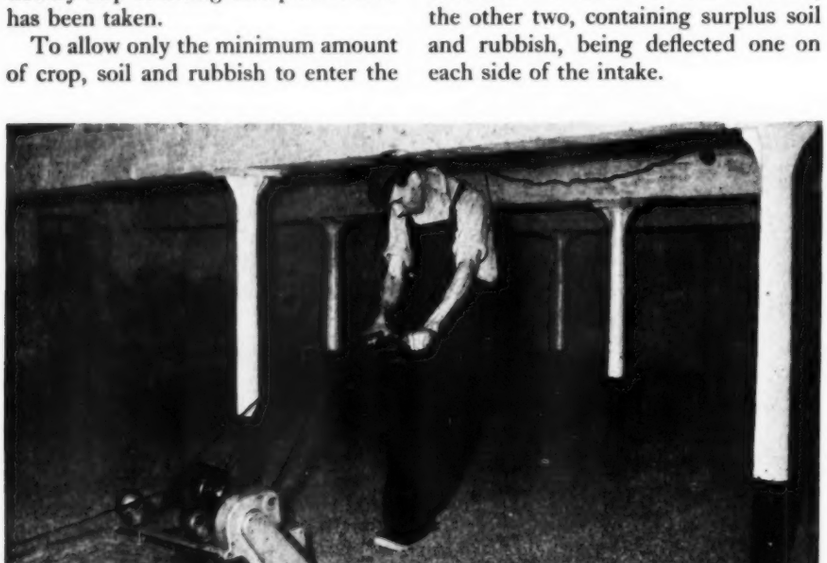
Packman potato harvesters being assembled

clay and fine sand—wet conditions of harvesting would make it impossible for a pneumatic wheel-mounted machine to function.

Potato growers also appreciate that soil conditions may vary considerably in different parts of the same field and maximum mechanical harvesting efficiency can only be achieved if a machine is buoyant enough to prevent sinkage. Because of this the revolutionary step of fitting caterpillar tracks has been taken.

To allow only the minimum amount of crop, soil and rubbish to enter the machine, Storeys have fitted a disc-coulter unit with facilities for using four separate types of discs, the whole unit having lateral, vertical and angular adjustment.

The discs can very simply be set to cut the sides of the drills, including any straggling haulm which is present, and to create three streams of flow, the centre stream containing potatoes along with the minimum of soil and rubbish is directed over the share, the other two, containing surplus soil and rubbish, being deflected one on each side of the intake.



Turning with the new malt turner. The operator draws the machine steadily backwards through the grain

This flow control lightens the work of the machine at various stages and enables the number of hand-pickers to be reduced. In fact, a complement of five hand-pickers would only be required under the heaviest conditions.

The drill tops are trimmed by an efficient haulm stripper, working in conjunction with the disc - coulter arrangement. This trimming of drills prior to starting their flow through the machine was seen to be of paramount importance during the 1954 harvest tests and was the basis for carrying out modifications to the wheels, coulter unit and to the intake itself.

Malt Turner

A new malt turner, type PMm, has been developed by Thomas Robinson and Son Ltd. It is stated that this machine works twice as fast as the most skilled hand turner, that it can be used by a man who has had little or no malting experience, and can be operated in any building with a mains electricity supply.

In appearance the machine is about the size and shape of a lawn mower. The rotor is 7 in. (178 mm.) in diam. and has eight blades. It is carried on a solid shaft, mounted in self-aligning bearings, and is driven through a totally-enclosed roller chain drive. The motor is encased and is mounted on top of a rigid yet light cast aluminium frame. It is coupled directly to the spur gear shaft which drives the chain assembly.

A transformer is supplied which reduces the main supply to 110 volts. A by-pass linkage ensures automatic earthing at 55 volts. These features give absolute safety under the dampest conditions prevailing on the malting floor and conform to the appropriate factory regulations.

A pick-up blade runs across the full width of the machine from the lower limits of the two end frames. It is positioned so that in operation every grain is fed to the rotor and deposited lightly some feet behind the machine in an undamaged condition. Projecting toes on the frame protect the rotor blades from the actual floor surface; uneven floors do not, therefore, impede the machine. Rubber roller castors are fitted so that the machine can be turned over and wheeled easily from place to place or from floor to floor.

WORLD CROP REPORTS

WORLD

Rice production. World* rice production in 1954-55 (August-July) is forecast at 2% less than in the year before in the first estimate of the U.S. Foreign Agricultural Service. The total crop being harvested and to be harvested is estimated at 262.3 thousand million lb. of rough rice, compared with 268.8 thousand million lb. in the preceding year, and with 229 thousand million lb. in the post-war average (1945-46/49-50) period. The indicated decrease of 2% from last season is almost entirely in the rice crops of Asia, which this year account for 88% of the world harvest, excluding Communist China, North Korea and the Soviet Union. Record harvests, however, are in prospect in all other world areas, with the possible exception of Oceania.

Larger than average crops are being harvested in the Northern Hemisphere. North American crops either exceed or equal the high level of a year earlier in all countries, except Nicaragua. The United States has the largest gain in volume as a result of a 12% increase in acreage and record yields per acre. The United States crop is 18% larger than the previous record made in 1953.

Prolonged rains in Cuba prevented the planting of a part of the increase in area intended to be seeded in rice. Plans include the planting of this acreage in rice at the time the second crop is to be planted in February 1955. Since the per acre yields of the spring crop usually are lower than those of the November harvest, however, it appears that the total rice production may not be so large as indicated earlier and only slightly more than in 1953-54. Mexico's acreage in rice exceeds the reduced plantings of the year before, and the crop is expected to be the largest in several years. Rice acreage in the Dominican Republic is reported to have increased at least 10%. Panama planted an acreage even larger than the sharp gain of the preceding year and yields per acre are expected to be as high as in 1953-54.

The rice acreage of Europe, excluding the Balkan countries, increased 4%, but production is forecast at only slightly larger than a year earlier. Crop losses in Spain reduced prospects for a record harvest. On the other hand, improved weather in Italy towards the end of the season may result in a crop exceeding earlier expectations.

Availability of water supplies in Egypt this season permitted the planting of the largest acreage in four years and above average yields are being harvested. The rice crop increased 25% over that of a year ago. Despite this gain, production is only about 75% of the post-war (1945-46/49-50) level. Iran and Iraq put more acreage in rice this year and both countries are harvesting bumper crops. Turkey is believed to have approximately the same acreage in rice and slightly higher yields.

Growing conditions in Japan turned favourable in the last part of the season and a record acreage was harvested. The crop was much better than expected in mid-season, when cool weather and typhoon damage presented conditions somewhat like those which lowered the yields sharply in 1953. Korea reportedly had about the same area in rice as in 1953. Although weather was favourable for growing, yields are reported to be somewhat below those of last year. This results in a near-record crop. Sufficient information is not available with respect to the rice crop of Communist China to determine the extent of acreage lost in the August floods. It is believed, however, that the rice acreage was reduced considerably and that crop losses were heavy.

Smaller harvests than last year are expected in most of the countries of the Far East, where the crop is now growing and will be harvested principally in December. The largest reduction may be expected in India and Pakistan, where floods reduced the planted acreage. This situation was completely reversed from that of a year earlier, when favourable weather in those countries at planting time permitted the seeding of a maximum acreage.

Burma's acreage planted is reported to be smaller than in 1953-54, but the extent of damaged area is less, which results in a slightly larger acreage harvested. Because of dry weather in some districts, the yields per acre are expected to be about the same as the below-average yields of the year before. Although Thailand's acreage planted was indicated to be about the same as in the preceding year, drought in the north-west and north-east is believed to have resulted in a smaller harvested acreage. With average crops in the main central growing area and good yields in the south, however, early indications are that Thailand may harvest about an average yield per acre for the country. In Indo-China, a smaller acreage is reported to have been planted in rice.

Ceylon is continuing to put into operation projects to increase rice acreage. The fall crop of 1954 was good and if more-than-acreage yields should obtain in the spring crop (February) production could be higher than presently indicated.

Rice acreage in South America is continuing to increase, especially in Venezuela, Colombia and Argentina. Brazil's acreage is expected to show a moderate gain, and the harvesting of average yields per acre would result in a 7% increase compared with the reduced crop of 1953-54. Rice is only now being planted in the southern countries of the Southern Hemisphere.

Present prospects indicate that the total rice production of the world's surplus countries will be slightly less than in 1953-54. Declines in the surplus countries of Asia are partially offset by gains in the Western Hemisphere, Middle East and Africa. Total 1954-55 production in the rice surplus countries of the Far East—Thailand, Burma, Indo-China, Taiwan, Korea and Pakistan—adds to 83,400 million lb. of rough rice, as compared with 88,500 million lb. in the preceding year (25.7 million metric tons of milled rice, compared with 27.3 million tons).

The largest increase in rice production in the surplus countries of the world is in the United States, where the harvest is 600 million lb. of rough rice (180,000 metric tons milled) larger than last year. Brazil could have a crop amounting to 500 million lb. rough (150,000 metric tons milled) more than in 1953-54 if average yields per acre are harvested.

*Excluding Communist China, North Korea and the Soviet Union.

Rice production in the surplus countries of the Middle East and Africa—Iran, Iraq, Turkey, Egypt and Madagascar—is estimated to be approximately 500 million lb. rough (150,000 metric tons milled) larger than in 1953. Total exportable supplies of Europe are expected to be not greatly different from the year before.

Foreign Crops and Markets

Sugar. *C. Czarnikow's Review* No. 177, of November 25, contains their first full estimates of world sugar production during the current season, with comparisons of the previous five years, the 1939-40 crop, and the pre-war campaign 1937-38. Details of the total beet and cane crops during these years are as under:

Thousands of tons	*Beet*	*Cane*	*Total*
1954-55*	14,279	24,449	38,728
1953-54†	15,746	24,370	40,116
1952-53	12,841	23,249	36,090
1951-52	12,941	24,113	37,054
1950-51	13,096	22,162	35,258
1949-50	10,432	20,768	31,200
1939-40	11,455	18,337	29,792
1937-38	11,054	18,007	29,061

*Estimated. †Partly estimated.

It is necessary to emphasise the fact that world totals do no more than provide an indication of the general trend of production. They can give no sort of statistical picture of annual supplies, for, quite apart from the fact that stocks now play an increasing part in the supply and demand set-up, there is a very considerable overlapping in the seasons of manufacture. The beet industries of the world, for instance, at November 25 are well into their harvesting seasons, but, so far as Europe is concerned, there is a good deal of beet to be got into the factories before sugar tonnages can be estimated with any degree of accuracy. There are some cane producers in the East who are now beginning to open their campaign; others, again, who are included in the 1954-55 year will not start to crush for several months. In the Western Hemisphere there will be many countries which will be starting up in the beginning of the New Year, but it is still not yet possible to give close estimates.

It will be seen that the current total beet and cane crops are estimated at some 1½ million tons behind the 1953-54 season, which may well stand as a record for a little while to come, but this reduction occurs entirely in the beet total, in which Europe figures with a 1,650,000 tons smaller output. It is of interest to note that at this time in 1953 the European crop was estimated at almost the same figure as the current crop is today. An upward adjustment of some 400,000 tons was subsequently made in 1953 in the Russian output, and all the other countries went on to exceed their estimated total by 1¼ million tons. In 1954, there has been little in the way of compensation for the dreadful weather conditions in Europe during the growing period and it had been expected that forecasters would have to reduce their ideas. This has actually happened in the case of a few of the smaller countries, but the reductions have so far not been of great importance. In one or two instances, notably Western Germany and France, contrary to general expectations, additions have been made to earlier forecasts. In the latter case, however, the addition may be due more to an adjustment in the sugar equivalent of beets which are to be diverted from distilleries than to yields above earlier expectations.

The fact that the total of cane sugar production shows little change from 1953, and, in fact, is little more than that of three years ago, is indicative of the restraint which it is necessary nowadays to place on production in a number of countries. Production totals are in one or two important instances below the sugar tonnage which could be produced if all cane were cut. Indeed, it is no exaggeration to say that, were there no necessity to limit the harvest, world sugar production could substantially exceed last season's record. Unlimited Cuban production alone could achieve this.

ENGLAND AND WALES

Agricultural report. Agricultural conditions in England and Wales on December 1, 1954, have been summarised by the Ministry of Agriculture.

Weather conditions. The weather during November was very wet in most areas and high winds were experienced. Unsettled weather set in during the first week, culminating in storms on the 11th and 12th. Some improvement followed and lasted for a week, when stormy weather again set in and lasted with only brief respites until the end of the month. Widespread flooding occurred during this period, floods being particularly bad on the western side of the country, and gales were also widespread.

Autumn cultivations and sowing. Conditions were unfavourable for cultivation and sowing and, except on some lighter soils, very little progress was made during the month. Work was decidedly in arrear.

Early sown wheat looked well generally; germination was slow on some heavier soils. Damage by slugs was reported from several areas. The small acreage of barley sown germinated well. Early sown oats germinated well, but later sowings were slow. Rye germinated satisfactorily and was healthy. The few crops of beans sown germinated well and appeared to be healthy.

Potatoes. Good progress was made with the lifting of potatoes on the eastern side of the country, but elsewhere conditions for lifting during November were very unfavourable and hindered progress. Tubers were generally dirty. Some blight damage was reported, but on the whole quality was satisfactory.

CANADA

Red clover seed production. The red clover seed crop is placed as on November 4 at 3,890,000 lb. of clean seed—a reduction of over 2 million lb.—with production less than 40% of the 1953 crop. The greatest loss occurred in Ontario due to heavy rains, floods and winds that accompanied hurricane 'Hazel' on October 15 and 16. Furthermore, outturn of the crop that has been threshed to date was much less than expected, due to sprouting and a high percentage of brown, shrunken, immature seed. Dockage will be unusually high in most cases.

In Western Canada, where production is chiefly the single-cut type, a slight downward revision in production is indicated as yields in Saskatchewan have been disappointing. On the other hand, improved harvesting conditions in Alberta and an increase in price have encouraged growers to harvest seed that normally would have been abandoned because of low yields.